Compressed Air Magazine

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FEBRUARY 1959

IN THIS ISSUE:

THE STORY OF AIR GUNS
ABOUT OUTBOARD MOTORS
URANIUM MILLING
BRITISH COLUMBIA'S LATEST REFINERY
INDEX AND COVER STORY, PAGE 3

BULK RATE
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Form 3547 Requested

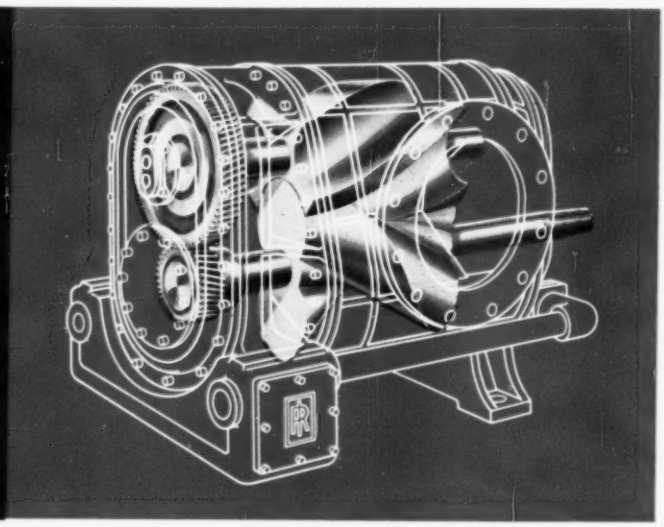
IN A CLASS BY ITSELF...

the Axi-compressor

Not Reciprocating...
Not Centrifugal...
It's an

AXIAL FLOW ROTARY COMPRESSOR

Capacity 100 12,000 cfm
Pressures to 15 psig
Vacuums to 15" Hg.



BECAUSE of its unique rotary design, the Ingersoll-Rand *Axi-compressor* delivers air or gas with less power in a smaller space than other types of compressor of equivalent capacity. It is equally suitable for pressure, vacuum or combination operation.

Utilizing the axial flow, positive displacement principle, the Axi-compressor discharges air smoothly and continuously, free from shocks. There are no pistons or valves, and the only moving parts are two perfectly balanced helical rotors which operate with minimum noise or vibration. The rotors never touch each other or the casing. Hence there's no need for internal lubrication.

Advantages:

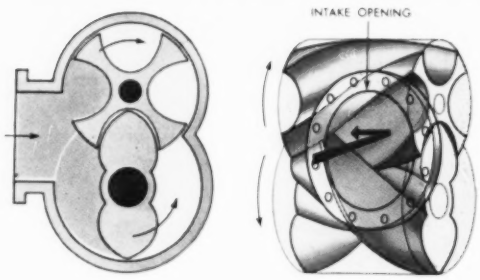
- **Space-Saving, Compact Design** – can be installed on simple, low-cost foundations.
- **Clean, Oil-Free Air** – no danger of contamination from lubricants.
- **Smooth, Pulsation-Free Compression** – no bulky air receivers required.
- **Operates at Higher Motor Speeds** – can be direct driven without belts or gears.

Ask your Ingersoll-Rand representative for complete information. Or send today for a copy of Bulletin 11,001A.

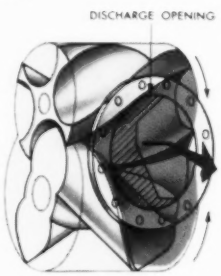
Ingersoll-Rand

11-841 11 Broadway, New York 4, N. Y.

HERE'S HOW IT WORKS...

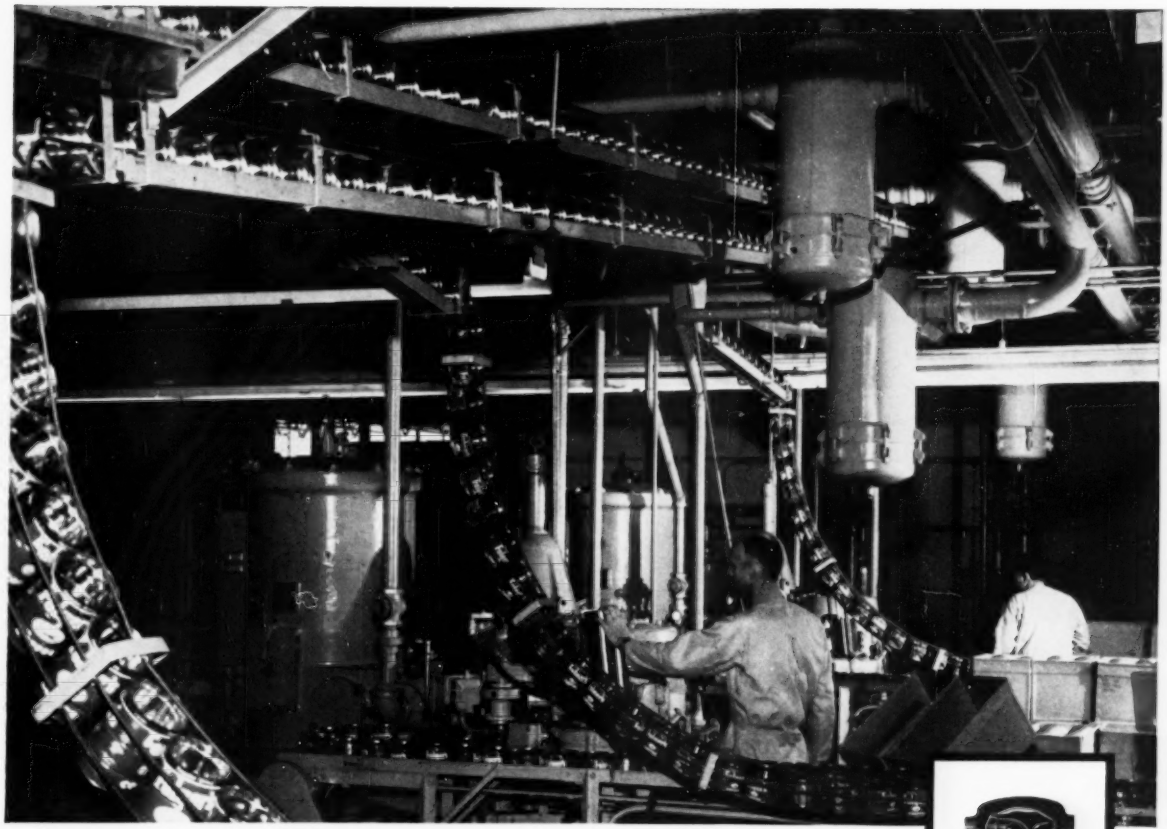


Intake: During the inlet cycle rotors are turning away from each other, drawing air or gas into the inlet space. This gas is then moved around to the discharge side of the compressor.

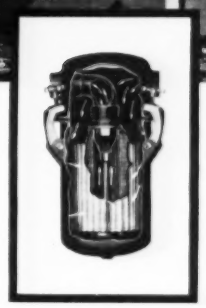


Compression and Discharge: During the discharge cycle the rotors are turning toward each other. They displace the inlet volume and air is smoothly compressed and forced axially toward the discharge opening.

PUMPS • CENTRIFUGAL & RECIPROCATING COMPRESSORS • DIESEL ENGINES • AIR & ELECTRIC TOOLS • TURBO BLOWERS • STEAM CONDENSERS



STAYNEW FILTERS KEEP TROUBLE FROM BREWING AT FOLGER'S COFFEE PLANT



Model CVH Staynew Filter used at Folger's. Filter inserts consist of Feltex 12 wool felt, are cleaned only once weekly.

At Folger's multi-million dollar plant in Los Angeles, Staynew Pipeline Filters play a vital role in vacuum packing—in fact, they literally keep trouble from brewing.

In vacuum packing shutdowns for pump repair cannot be tolerated. Pumps "suck" air from coffee cans before they are sealed for shipment. When this air is drawn off, some coffee particles are bound to come with it. At Folger's, Staynew Filters protect the vacuum pumps by preventing these particles from getting to them. Located between the production line and the pumps, Staynew Filters first mechanically clean the incoming air by forcing heavier particles into the base of the housing. Then, flowing through the Radial Fin Filtering Insert, any remaining airborne materials are removed, leaving only clean air to pass to the pump. Mechanical separation before filtering reduces the load on the filtering element. Low velocity with unusually low resistance to flow results. This keeps line pressures at the proper operating level and offers a tremendous saving in horsepower.

Designed to eliminate frequent cleaning, Staynew Filters contain a liberal space in the bottom housing for large particle accumulation — this can be drained off without shutdown. The Radial Fin construction of the filtering element provides an extremely big active filtering area—this means a greater amount of filtering over a longer period of time. For inspection and cleaning, large swing bolts permit removal of the lower housing, offering easy access to the filter interior without breaking pipe connections.

Assuring sustained, trouble-free operation of pumps at high load factors, Staynew Pipeline Filters have been successful in the packing of millions of pounds of coffee annually at Folger's. They've also gained wide acceptance in the processing of canned meat and other foods, and on vacuum degassing and high vacuum metal processing systems, to name a few. There's a Staynew Filter for every job—find out how you can save time and money on your particular application—consult a Dollinger representative, or write for Bulletin 200. Dollinger Corporation, 7 Centre Park, Rochester 3, N. Y.

REG PROTECTOMOTOR U.S. PAT. OFF.

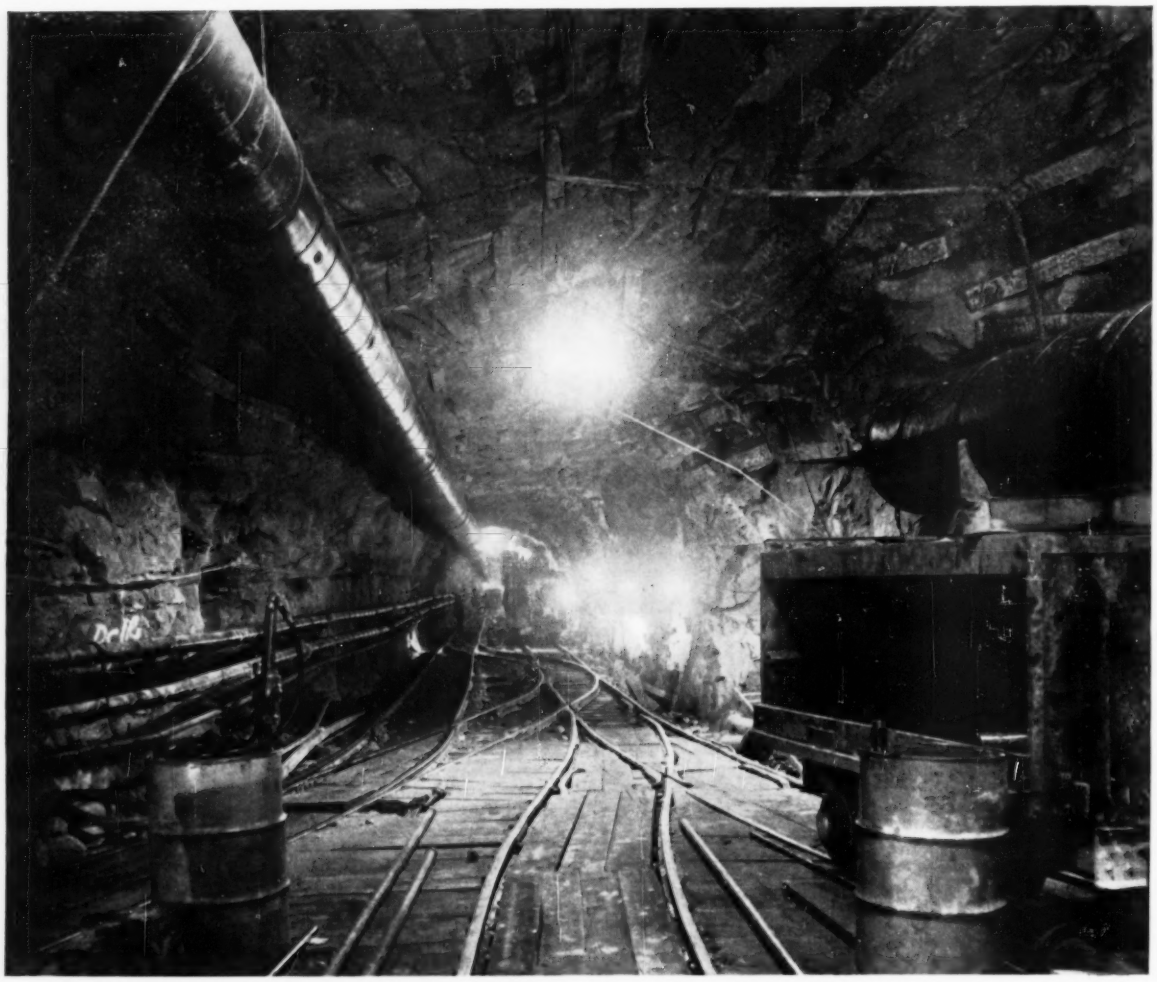
STAYNEW FILTERS

DOLLINGER

SPECIALIZING IN DRY TYPE FILTERS FOR OVER 35 YEARS

LIQUID FILTERS • PIPE LINE FILTERS • INTAKE FILTERS • HYDRAULIC FILTERS • ELECTROSTATIC FILTERS • MIST COLLECTORS • DRY PANEL FILTERS • SPECIAL DESIGN FILTERS • VISCOUS PANEL FILTERS • LOW PRESSURE FILTERS HIGH PRESSURE FILTERS • AUTOMATIC VENTILATION FILTERS • NATURAL GAS FILTERS • SILENCER FILTERS

The Right Climate For Underground Operations



Keeping underground working areas free of gases and fumes and supplying fresh air for tunnel work is no problem when you use NAYLOR Spiralweld pipe lines.

This dependable pipe is light in weight, easy to handle and install, strong and safe in service—particularly on push-pull ventilating operations. And when you make connections with the NAYLOR one-piece Wedgelock Coupling, you can set up lines quickly with just one side of the pipe in the open. **For the details, write for new Bulletin No. 59.**

NAYLOR PIPE *Company*

1245 East 92nd Street, Chicago 19, Illinois

Eastern U. S. and Foreign Sales Office: 60 East 42nd Street, New York 17, N. Y.

Compressed Air Magazine

Founded 1896

VOLUME 64 NUMBER 2 **February 1959**

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ON THE COVER

MORE and more the construction of buildings is moving into the factory. The use of lightweight panels as curtains or nonloadbearing exterior walls is a good example of the factory-built concept. Current industry estimates place curtain wall volume at $100 million annually—the figure is expected to reach $325 million by 1965. Curtain wall design has come to symbolize contemporary Western architecture in much the same way that Gothic or Renaissance styles characterize earlier eras. The structure pictured on the cover is the Equitable Life Building, San Francisco, Calif. Vertical columns are marble-faced; window and spandrel units are of aluminum with stainless steel mullion covers. The panels were prefabricated by Kawneer Company.

FEATURE ARTICLES

Page 12 **Air Guns**—*G. R. Smith*

High on the list of "super weapons" that didn't spell the end of the world are air guns. Viewed at one time by Napoleon's troops as something akin to the A-bomb, air guns have a fascinating background. This first section of a 2-part story reviews their history up to the beginning of modern day air weapons.

16 **Sea Cow**—*J. P. Smallwood*

Once regarded as a cantankerous and perverse inanimate object, the outboard motor is now a reliable piece of equipment. The mass production of outboards in Canada is detailed in this article. The role played by pneumatic tools and compressed air is outlined.

20 **First Uranium Mill On Rockies' East Slope**—*Carey Holbrook*

This country's chief source of uranium ore was for long the deposits on the western slopes of the Rocky Mountains. In recent years, high-grade ores have been found on the east slope. To process them, a mill utilizing new beneficiation treatments has been built near the rich mines.

23 **Further Expansion In British Columbia**—*Peter Sleight*

British Columbia is enjoying a brisk boom. The Canadian province has been helped along by a new petroleum refinery, result of a $25 million venture by British American Oil Company, Ltd. Incorporating many processes new to the area, the refinery has been called one of the most modern in North America. The uses of compressors and pneumatic equipment in its construction and operation are pictured.

33 **Controlled Sound Of 160 Decibels**

The instrument described may be able to project the human voice more than 10 miles. Its more practical aspects are discussed.

34 **Pen Or Pencil Drawings Guide Flame Cutters**

In replacing templates, photoelectric cells have found another industrial application.

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BA Iron & Steel Fulflo Filters
Three sizes — for 3″, 5″ and 7″ Honeycomb Filter Tubes — have maximum operating pressure of 125 psi, maximum flow rate of 150 scfm, with initial pressure loss of only 3 psi. BR7A model is available in nickel-plated brass.

AF Iron & Steel Fulflo Filters
Maximum flow rate is 180 scfm at maximum operating pressure of 250 psi. 7″ Honeycomb Filter Tube.

There's a *Fulflo* filter for the operating pressure on your job

Fulflo Filters protect your pneumatic equipment by minimizing gumming — removing moisture, oil, microscopic rust, dust, dirt and scale. Here are some examples of Fulflo Filters for a wide range of operating pressures and flow rates. Multi-tube models are available for large flow rates and central installations. Write for new booklet to Dep't C.A.

4.5CA-¾
Iron & Steel Fulflo Filters
Designed for operating pressures as high as 450 psi. Maximum flow rate is 300 scfm. 7″ Honeycomb Filter Tube.

SS7.5C-10¾
Stainless Steel Fulflo Filter
Maximum flow rate is 400 scfm at operating pressures up to 750 psi. 10″ Honeycomb Filter Tube.

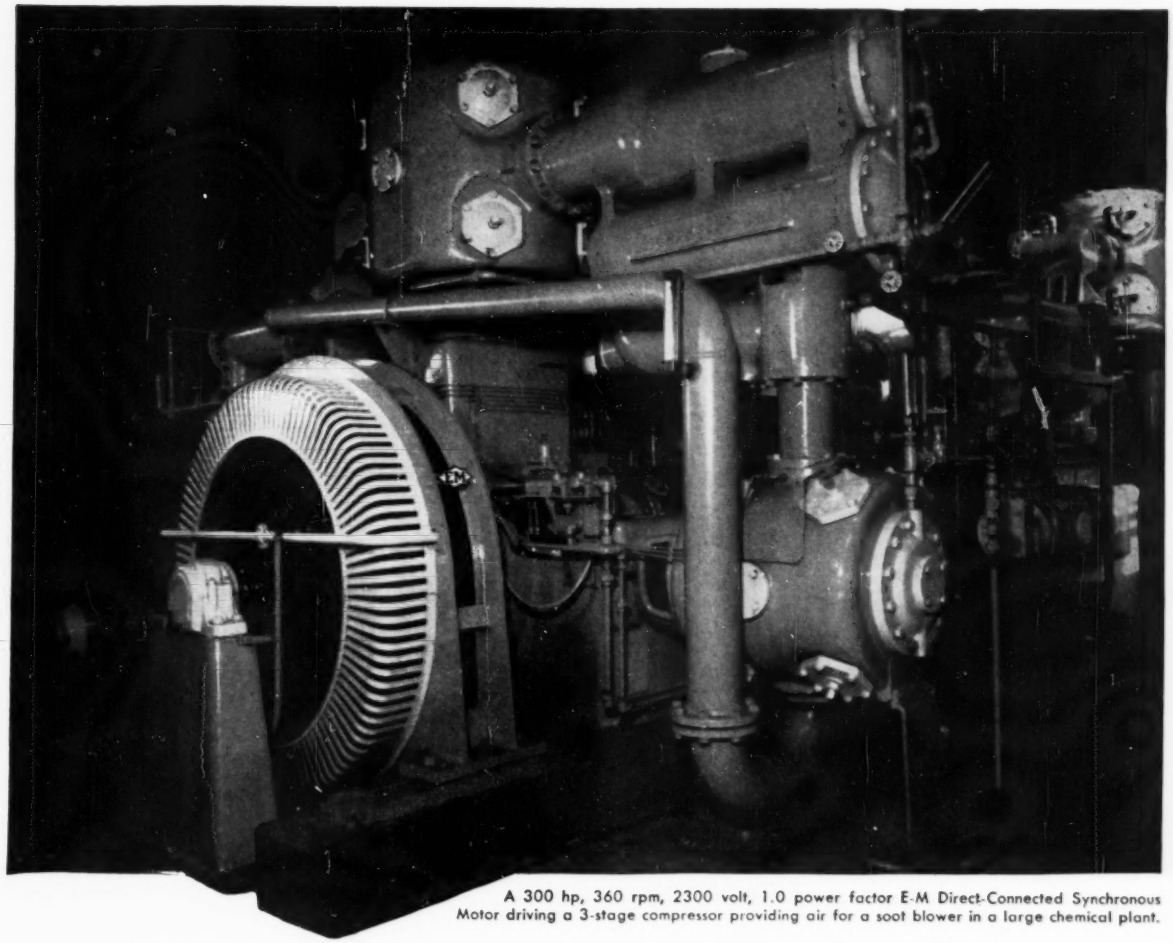
4MXA Steel Fulflo Filter
High pressure filter has maximum flow rate of 800 scfm, at pressures as high as 4,000 psi. 7″ Honeycomb Filter Tube.

COMMERCIAL FILTERS CORPORATION
MELROSE 76, MASSACHUSETTS
PLANTS IN MELROSE, MASSACHUSETTS AND LEBANON, INDIANA

MICRO-CLARITY AT MINIMUM COST

Fulflo Filters — *with genuine Honeycomb Filter Tubes for controlled micro-clarity of industrial fluids.*

CFC Filters — *Selective filtration of oils • water-oil separators • magnetic separators • pre-coat filters • coolant clarifiers • automatic tubular conveyors.*



A 300 hp, 360 rpm, 2300 volt, 1.0 power factor E-M Direct-Connected Synchronous Motor driving a 3-stage compressor providing air for a soot blower in a large chemical plant.

What every new compressor should have

● Nicest thing you can do for a new large compressor is to couple an engine-type synchronous motor to it. There's no better way to assure a most economical, reliable and trouble-free drive. Look at the advantages:

1. HIGH EFFICIENCY conversion of electric power to mechanical power by synchronous motors . . . resulting in minimum electric power cost operation of the compressor.

2. POWER FACTOR CORRECTION by unity or 0.8 leading power factor synchronous motors . . . supplying leading reactive kva to improve plant power factor and further reduce power costs, save money on your power bills.

3. DIRECT-CONNECTED synchronous motors save valuable floor space and require minimum maintenance.

4. SIMPLE STARTING at full voltage is suitable for most direct-connected synchronous motor compressor applications. Or you can use E-M-invented part-winding starting where starting limitations are severe. E-M starting arrangements are low in first cost and maintenance cost.

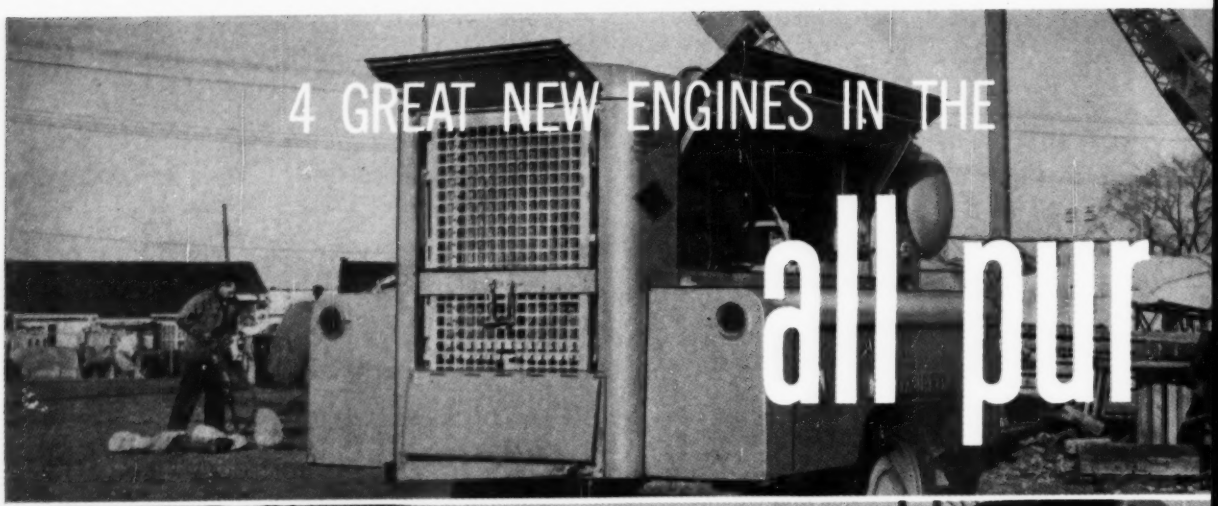
And there's nothing nicer for your compressor than an *E-M* Direct-Connected Synchronous Motor. E-M, pioneers in the development of synchronous motors and control, have over 40 years' experience in the design of synchronous motors incorporating desirable characteristics and features such as those above.

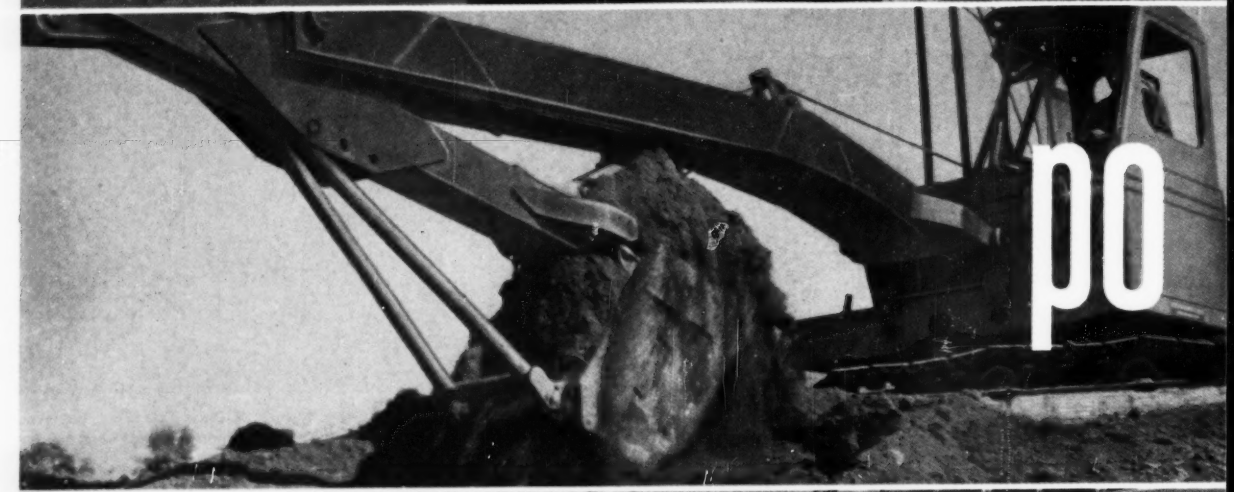
Let the E-M specialist engineer team design a smooth-running, modern drive unit to meet the requirements of your new compressor application. For complete information on E-M Synchronous Motors and their application in your plant, consult your nearest E-M sales engineer. And write for the issue of the E-M Synchronizer titled "The ABC of Synchronous Motors".

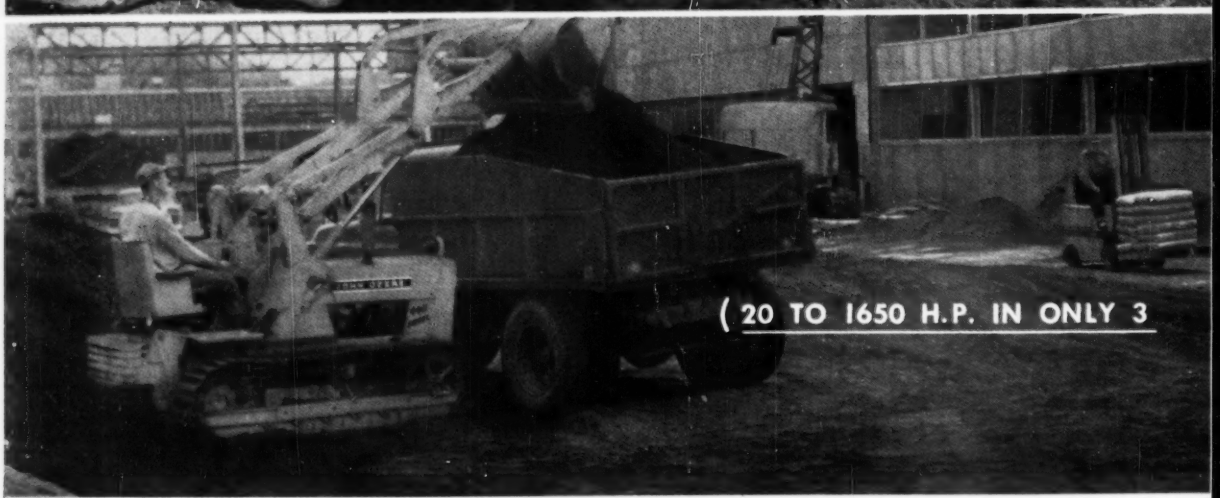
ELECTRIC MACHINERY MFG. COMPANY
MINNEAPOLIS 13, MINNESOTA

1200-TPA-2136

E-M *Specialists in* **BIG MOTOR ENGINEERING**







THE GM DIESEL ALL-PURPOSE POWER LINE
20 to 1650 H.P.
in only 3 cylinder sizes

NON-TURBOCHARGED RATINGS

NEW
"2-53"
20 to 47 H.P.

"2-71"
33 to 67 H.P.

NEW
"3-53"
38 to 97 H.P.

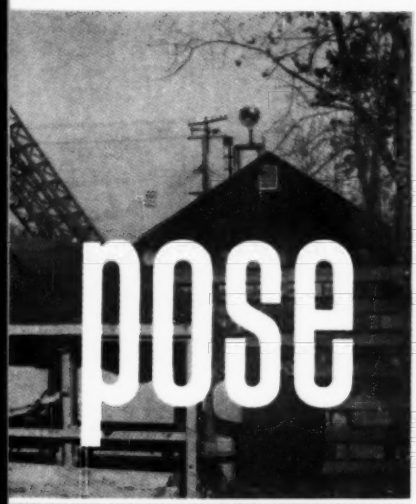
"3-71"
51 to 118 H.P.

NEW
"4-53"
51 to 130 H.P.

"4-71"
69 to 167 H.P.

NEW
"6V-53"
76 to 195 H.P.

"6-71"
112 to 252 H.P.



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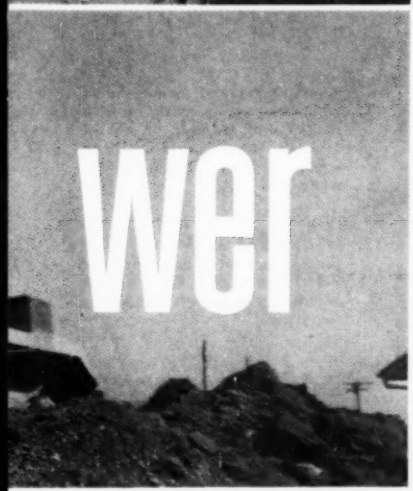

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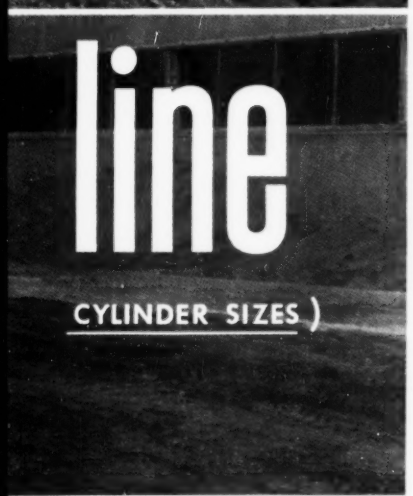

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CYLINDER SIZES)

The Series 53 "Jimmy" Diesels

NEW FOR THE CONSTRUCTION INDUSTRY

Smaller and more compact 2-, 3-, 4-, and V-6 cylinder engines based upon the dependable GM Series 71 Diesel

New as tomorrow is the power concept which GM Diesel has embodied in its All-Purpose Power Line to make you more money on every contract.

Using only 3 cylinder sizes, GM Diesel engineers have more than doubled the number of basic engines—vastly increased the power range—yet maintained the famous GM Diesel family relationship and parts interchangeability.

This concept is dramatically illustrated in the Series 53 "Jimmy" Diesel. For *only* in these Diesels are combined *all* the profit-making, cost-saving advantages *any* Diesel has ever had.

Compare them horsepower for horsepower:

> They cost less, weigh less, take up less room. Accelerate faster, last longer, and parts cost less. They're easier and less expensive to repair and maintain—far more efficient, too.

This Series 53 "Jimmy" Diesel is *literally* All-Purpose Power in the 20- to 195-H.P. range. Consider it for your needs. Write GM Diesel, Dept. C-2, Detroit 28, Michigan, and see what these new Series 53 "Jimmy" Diesels can mean to your construction profits.

GM DIESEL

DETROIT DIESEL ENGINE DIVISION,
GENERAL MOTORS, DETROIT 28, MICH.

In Canada:
GENERAL MOTORS
DIESEL, LIMITED,
London, Ontario

Parts and Service Worldwide

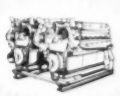
NEW
"6V-71"
112 to 252 H.P.

NEW
"8V-71"
150 to 334 H.P.

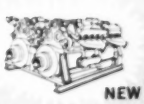
"6-110"
160 to 335 H.P.

NEW
"12V-71"
224 to 504 H.P.

NEW
"16V-71"
300 to 675 H.P.



NEW
"24V-71" (Twin 12)
448 to 1008 H.P.



NEW
"32V-71" (Twin 16)
600 to 1350 H.P.
(Turbocharged—1650 H.P.)

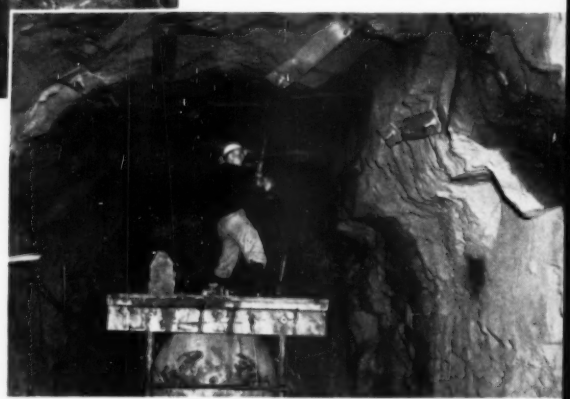
SMALL CAPITAL INVESTMENT
DOES A MAN-SIZE JOB

Dyberry Dam Tunnel finished ahead of schedule with ALL I-R EQUIPMENT

One of the Ingersoll-Rand JR-38B Universal Jackdrills at work on the tunnel face. Each round took 2 to 3 hours, and from 50 to 60 yards of rock were removed at each blast.

Roof-bolting holes were drilled with an assembly consisting of a JR-38B drill mounted on an I-R Jackleg. Investment in drilling equipment was thus kept to the minimum.

Working from a rubber-tired drill jumbo, operator tightens roof bolts with a powerful but light weight Ingersoll-Rand 308 Rotary Impactool.



This 600 cfm Gyro-Flo portable rotary compressor supplied ample air power for all operations—including the blowing of the noon whistle. Air was piped to both portals and drilling was done at one heading while mucking at the other.

The Dyberry Dam diversion tunnel is a small but vitally important part of the Lackawaxen River Flood Control Project. Under normal conditions, Dyberry Dam will be dry—river flow being by-passed through the 8-foot diversion tunnel. But under flood conditions, excess water will be impounded in a large reservoir, preventing damage to downstream communities.

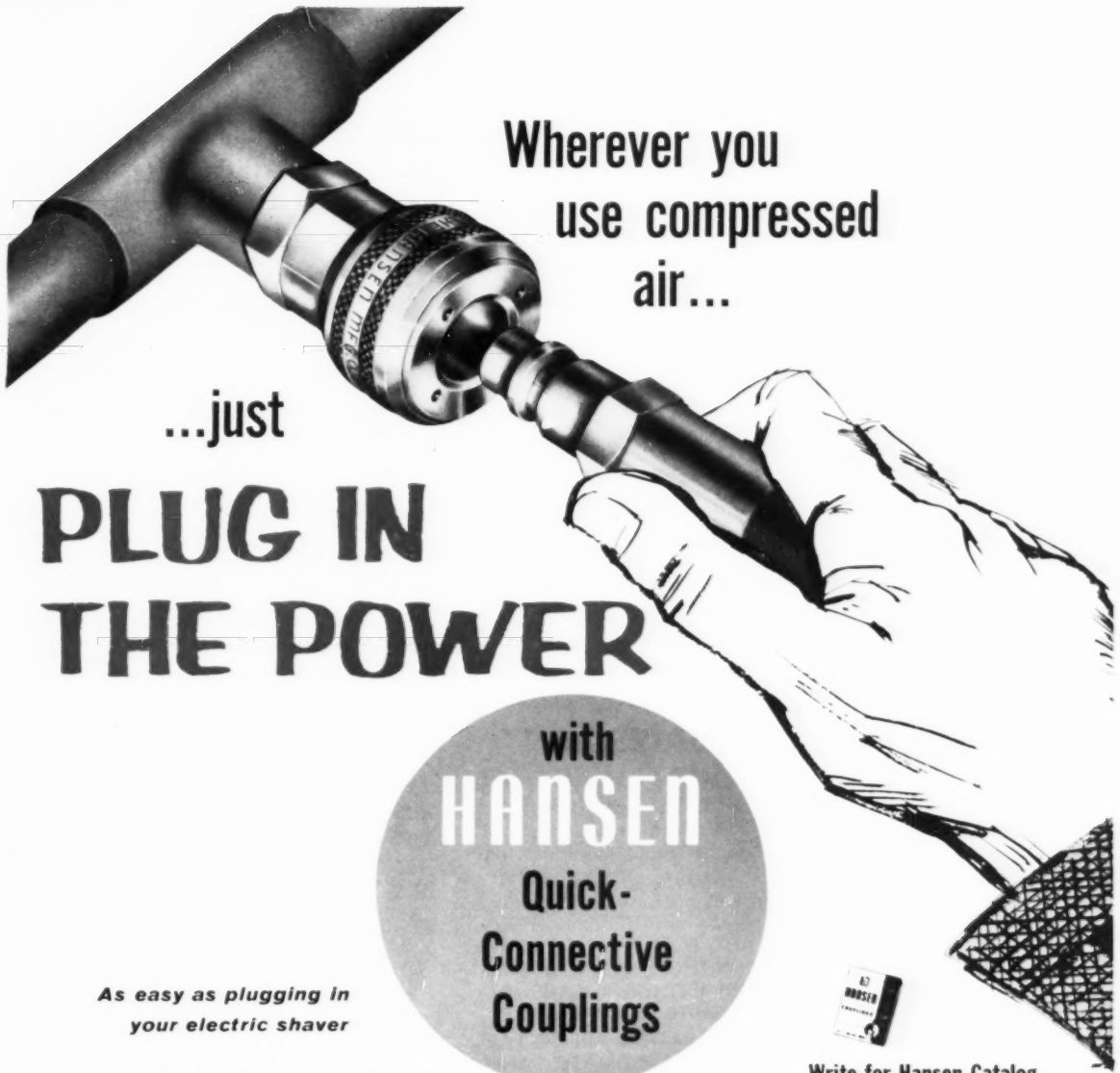
The Hunkin-Conkey Construction Co. of Cleveland, Ohio, contractor of the whole dam project, has completed the tunnel... months ahead of schedule with the Ingersoll-Rand equipment shown here. Using a burn cut hole pattern, JR-38B Jackdrills and Series 113—1½" Carset bits. Eight foot drilled holes advanced tunnel 7 to 8 feet per blast! Holes for roof bolting were drilled by Ingersoll-Rand JR-38B mounted on a Jackleg and roof bolts were set with I-R rotary Impactools. Air power for both headings was supplied by a 600 cfm Gyro-Flo portable compressor.

On large jobs or small, I-R equipment can meet every drilling requirement—and help you meet contract dates at lowest overall cost. Ask your I-R representative for any information you may need.

Ingersoll-Rand

5-845 11 Broadway, New York 4, N.Y.

A CONSTANT STANDARD OF QUALITY IN EVERYTHING YOU NEED FOR DRILLING ROCK



Wherever you use compressed air...

...just

PLUG IN THE POWER

with HANSEN Quick-Connective Couplings

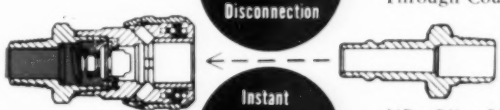
As easy as plugging in your electric shaver

To connect the Coupling, just push the Plug into the Socket — with one hand. Flow is instantaneous. To disconnect, push back sleeve on Socket. Coupling disconnects with instant, automatic shut-off of air.

Write for Hansen Catalog

—a ready reference when you want information on couplings in a hurry. Lists complete range of sizes of Hansen One-Way Shut-Off, Two-Way Shut-Off, and Straight-Through Couplings.

Quick Connection and Disconnection



Instant Automatic Flow or Shut-Off

Blue section shows how Socket, when disconnected, automatically shuts off air by leak-proof seal of metal valve against rubber valve seat.

Quick-Connective Fluid Line Couplings for

AIR • OIL • GREASE • HYDRAULIC FLUIDS
WATER • VACUUM • STEAM • OXYGEN
ACETYLENE • REFRIGERANTS • GASOLINE
COOLANTS • LP-GAS

Representatives in Principal Cities

SINCE 1915

QUICK-CONNECTIVE FLUID LINE COUPLINGS

THE HANSEN MANUFACTURING COMPANY

4031 WEST 150th STREET • CLEVELAND 35, OHIO

THE BIG

. . . SURPASSES EXPECTATIONS !

THE CASE OF THE DISAPPOINTED SALESMAN

Fred's a good salesman. Enthusiastic. Convinced of the proven superiority of the Eimco 105 Overhead Loader. But there are times when even a top salesman can't fight it. That was the case with Fred, when he wrote the following report to the home office:

"I have for many months been looking forward to getting another order for an Eimco 105 here*, but THIS ONE (Eimco 105 Overhead Loader) IS SO FAR AHEAD OF THEIR EXPECTATIONS AND THEIR PRODUCTION WITH THIS MACHINE IS SO NICELY HANDLED, THAT I DOUBT IF THERE WILL BE ANOTHER ORDER FORTHCOMING FOR QUITE A LONG WHILE."

"THEIR COSTS IN THIS MINING OPERATION ARE SO FAR BELOW THEIR CONSULTING ENGINEER'S ESTIMATES AND THEIR PRODUCTION HAS BEEN SO MUCH HIGHER THAN THEY EXPECTED, THAT THEY HAVE CURTAILED PLANS FOR EXPANDING THE DEVELOPMENT OF THIS PROPERTY."

What's a salesman to do? Fred had the answer. Make sure that other mining operators also learn about the savings potential, high production of the Eimco 105 Overhead Loader Crawler-Tractor. Fred, or one of his associates . . . the sales-engineers of The Eimco Corporation . . . will be glad to demonstrate the multiple advantages of the modern tractor . . . the rugged, reliable, maneuverable Eimco 105.

*—Original letter and name of mining company on file.

Just contact the sales office nearest you or The Eimco Corporation, P.O. Box 300 Salt Lake City 10, Utah, U.S.A. Tell 'em Fred suggested it!

B-379

THE EIMCO CORPORATION
SALT LAKE CITY, UTAH

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TOOLS REQUIRED FOR MAINTENANCE	NONE	Wrench	Wrench & Screw-driver	Screw-driver	Wrench	Wrench & Pliers
TOOL OPERATIONS REQUIRED	NONE	2	10	16	2	4

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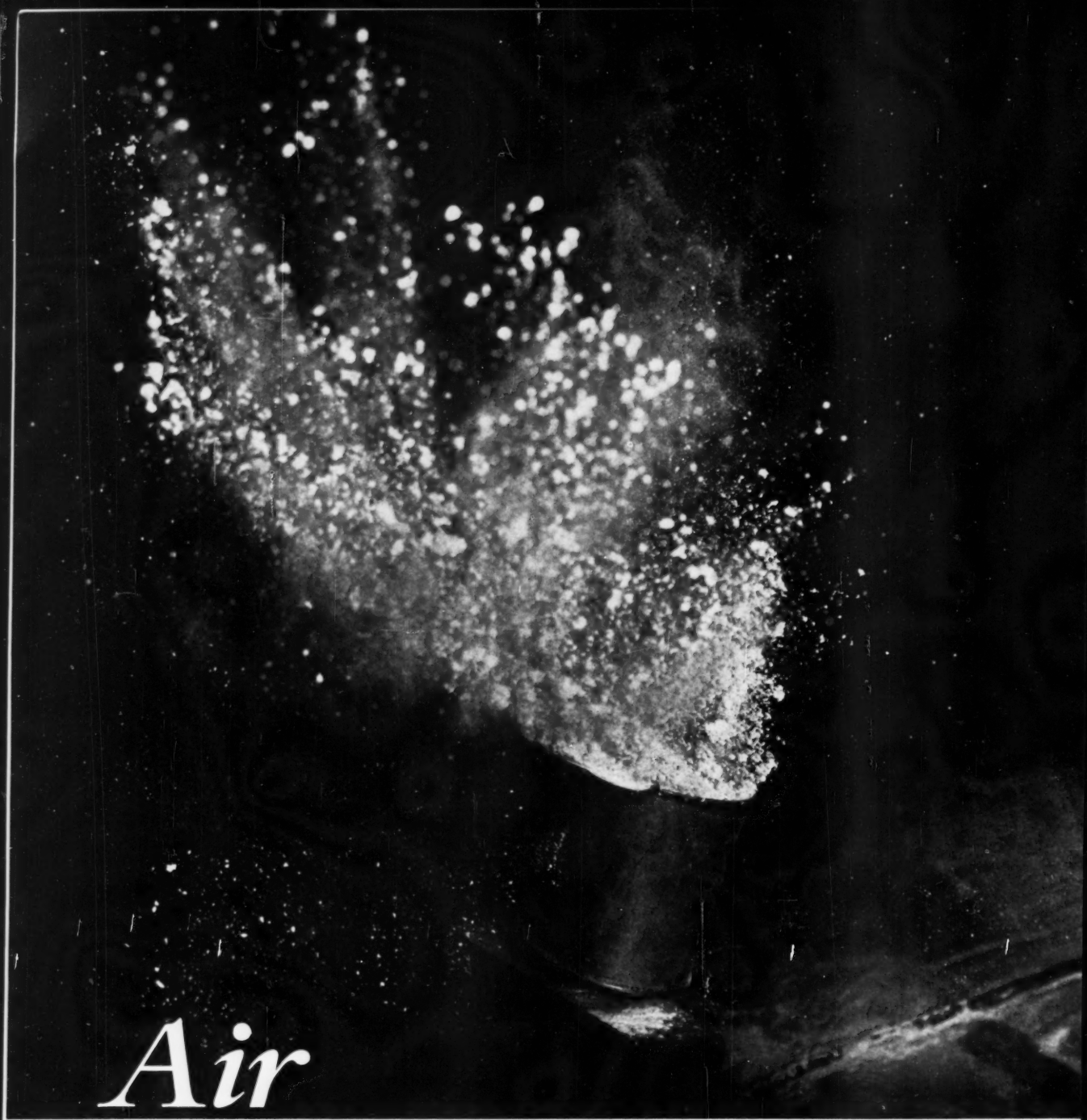


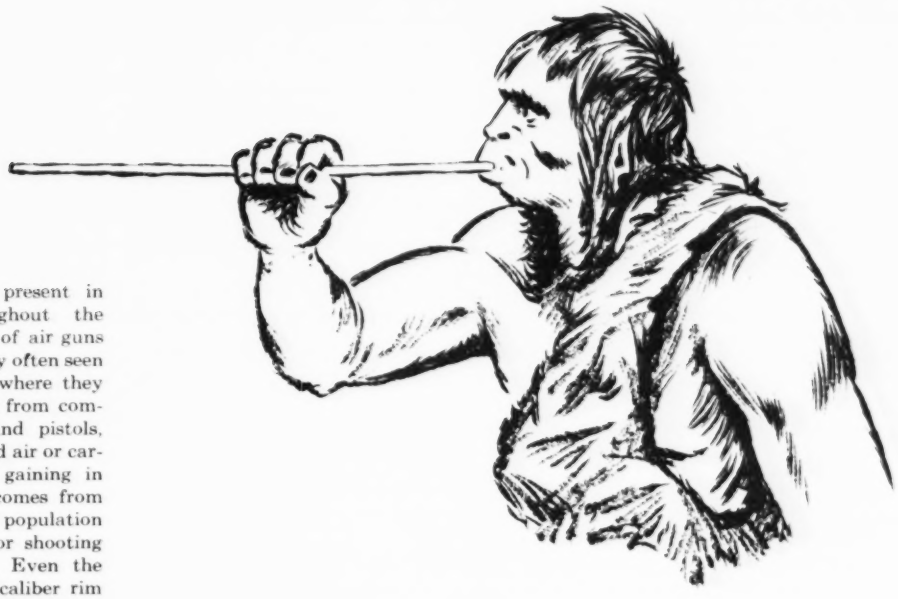
Air Guns

Part I

G. R. Smith

A stooped man, covered with dark hair and dressed in scraps of animal skins, examines the reed he holds in his hands. His forehead wrinkles thoughtfully as he reaches down to pick up a pebble. He puts the stone inside the hollow reed. It slides in smoothly. The man inhales deeply, then lifts the reed to his mouth, and blows with all his force. Startled, he eyes the pebble as it darts through the air: man's first air gun—the first gun of any type—has just been invented.

A scene like this one, during the years of unrecorded history, probably introduced mankind to the gun.



EARLIEST GUN

The first gun of any type was almost certainly some prehistoric man's lung-powered blowgun.

TODAY the blowgun is present in many forms throughout the world; other versions of air guns are familiar weapons too, very often seen in public shooting galleries where they are fed by air lines running from compressor receivers. Rifles and pistols, powered either by compressed air or carbon dioxide, are currently gaining in popularity. This increase comes from the growth and dispersal of population that have made safe outdoor shooting locations difficult to find. Even the range of the ubiquitous .22-caliber rim fire is much too great for safety in populated areas. The limited range of gas weapons, however, and their high accuracy within range, make them ideal for pleasure shooting.

Today's use of air guns as toys, instead of as more serious weapons, is a thriving business. Each year, approximately 1,500,000 boys and girls receive "BB" guns that, though classed as toys, provide excellent early weapons training. In many locales of the United States, there is hardly a boy who doesn't own an air rifle. Indeed, the trade name, Daisy, has become nearly as much a part of the American scene as Coca-Cola and Ford.

Historically, gas-powered arms have played a fascinating role through the years. Even the crudest air weapon, the lung-powered blowgun, is said to have a background of lore that would provide material for a 1000-page book. According to W. H. B. Smith, one of the world's foremost authorities on weapons, and author of the definitive *Gas, Air and Spring Guns of the World**, some 45 words, in as many languages, mean "blowgun." All guns are based on the blowgun principle—that of forcing a projectile through a tube by suddenly expanding gas.

Earliest knowledge about the blowgun is sketchy. There is information of its use in Asia and Asia Minor long before the beginning of Christianity. Much later, a Javanese historian wrote about a war waged against Bali in 1625, during which the use of poison-tipped projectiles was fiercely condemned. A Spanish author, Antonio Herrera y Tordesillas, 1549-1625, told about widespread use of blowguns by the Central American and Mexican Indians during the late sixteenth and early seventeenth centuries.

A French marine officer, Jean Bernard Bossu, published a series of letters in 1768 describing his travels through the Mississippi Basin of what is now the United States. He tells of the skill of Choctaw Indian children with their 7-foot-long blowguns. Such weapons were very common in much of the southern United States, where canes grew, but the names of the tribes that used them are little known today: Atticapa, Chetimacha, Muskhogean. These early Americans even devised a type of "revolver" blowgun consisting of reeds bound together, each being fired as its mouthpiece was turned to firing position.

The New World's foremost designers and users of hunting blowguns have always been the Indians of the Orinoco and Amazon basins of South America. There are said to be thousands of statements about their skill with air guns and poison arrows. The writings of an Englishman, Charles Watterton, in the early 1800's, contain the earliest first-hand knowledge of South Americans' use of accurate blowguns and the deadly poison, curare. Even today, it is produced in the steaming cauldrons of South America. This poison, a killer of amazing efficiency, has been tamed by physicians for use as an anesthetic.

Though identical in principle, blowguns vary considerably in construction. Thought to be the best of South American weapons is the Pucuna of the Guiana Macoushies. It is made from a reed, peculiar to the Orinoco regions, that has a diameter of about ½ inch and a length of about 14 feet. The reed is straight and has no joints. The internal diameter is uniform except for a slight contraction toward the end that produces a steadying effect on the flying darts. This contraction, also used in firearms, is called the Gerlach "squeeze-bore" effect when produced during barrel machining. (Gerlach was an early Berlin gunsmith.) Because this remarkable reed is very fragile, another more sturdy variety is placed around it for support.

Another type of blowgun is the Zarabatana of the Amazon region that is produced by fitting two grooved pieces of wood together, much like the construction of an ordinary lead pencil. The long, half-circle grooves are cut by use of incisor teeth of rodents.

On the Malayan Peninsula, aboriginal tribesmen, called Mautras, fashion their blowguns from two bamboo tubes, one sealed within the other, whereas natives in Borneo construct a unique weapon from a solid piece of ironwood. In his book, *Head Hunters of Borneo*, Carl Bock, onetime Dutch Commissioner of the Island, tells about these weapons. The bore is drilled while the wood is still in a very rough form. During the drilling, a second native pours water into the cavity to float away the cuttings. When the long drilling process is completed, abrasive leaves are used to ream out the bore and polish it. Only

*Published by The Military Service Publishing Company, Harrisburg, Pennsylvania, 279 pages, 1957.

FLOUR FLIES

At left, flour sprays from a can struck by a pellet "fired" from an American-made air rifle. This high-quality pump-up weapon can put a pellet through several inches of wood.

then is the outside of the blowgun finished, thus paralleling the manufacture of modern gun barrels in which drilling the bore is the first operation.

The history of blowguns in modern combat is interesting, although they have not been used extensively. In early years, they served as projectors of "Greek fire"—phosphorus compounds that ignite easily. Modern-day saboteurs reportedly have used blowguns for spreading fire with similar compounds. Agents of German Colonel Otto Skorzeny's espionage group are said to have carried bogus cigarettes containing curare-painted darts during World War II. Survival training given by intelligence organizations often instructs in the improvising of crude blowguns. Today, fortunately, blowguns are usually put to a more peaceful use, the most common, of course, being the ordinary peashooter.

When the descendants of the first users of blowguns discovered their lungs weren't as powerful as they wanted, they developed other means for compressing air and directing it through a barrel. The time of the invention of the air gun, in the form of a rifle or pistol, isn't positively known. For many years it has been the practice of ordnance authorities to attribute the invention to a gunmaker named Guter, of Nuremberg, Germany, in the year 1560.

These "facts" were recorded by one Auguste Demmin, a diligent and meticulous German arms researcher who lived from about 1823 to 1898. However, W. H. B. Smith is almost certain that the usually accurate Demmin was mistaken on this point. (Demmin's later editions change the invention year from 1560 to 1430.) Smith's reason for being skeptical springs from the invention times of the parent machines utilized by the three general types of air weapons. These include: (1) those that operate on the principle of the bellows; (2) those that operate on the principle of the condensing syringe or piston (by far the most common type today); and (3) those arms that have an independent air cylinder or flask that supplies pressure after being pumped up.

The bellows is traditionally associated with Anacharsis the Scythian, a philosopher who lived 600 years before Christ; however, it undoubtedly was known earlier than that. The condensing syringe was an old and familiar tool to the Alexandrian Greeks some 200 years before Christ. The independent air cylinder was known and utilized in the Middle Ages. Because the principles of all the types of air weapons were known so long before Guter's time, Smith says it is possible that the ancient Greeks were the first to use air guns; but he points out that no one knows for sure.

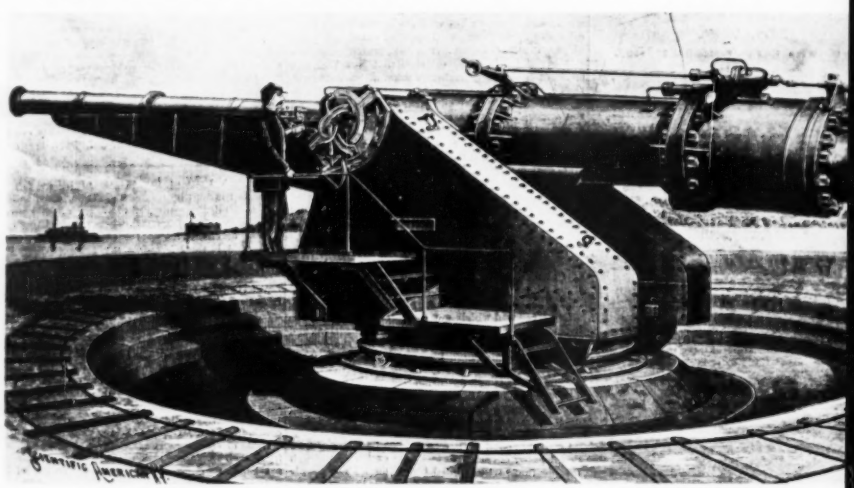
A contemporary of the famous Archimedes, Ctesibius of Ascra, developed a remarkable contraption using the syringe principle. The "Machine of Ctesibius" utilized two compressed air pistons, each connected to its own lever. A rope strung between the free ends of the levers held a heavy stone missile. When a trigger was tripped, air forced the pistons against the levers. This caused the relaxed string to tighten quickly with great force, hurling the missile like a huge, air-operated slingshot.

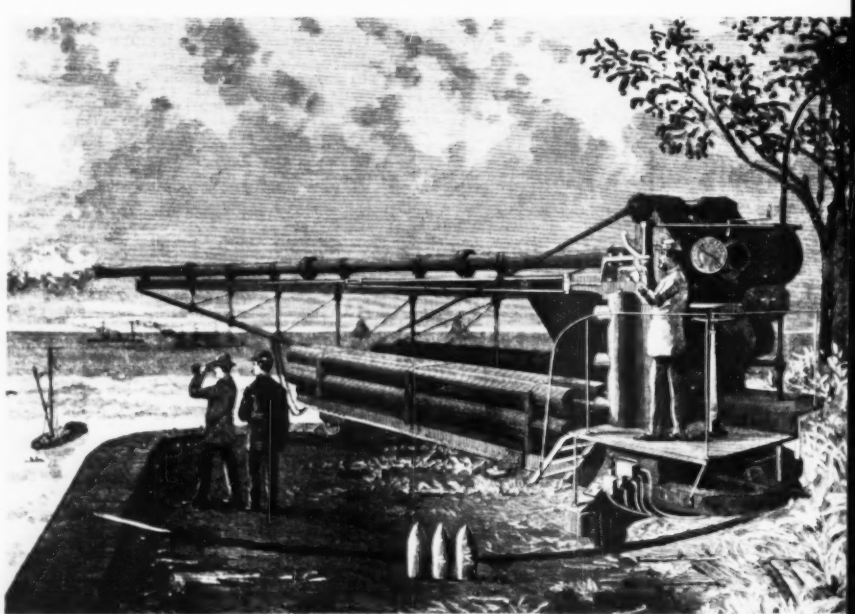
Hero of Alexandria is still another of the many who could have developed the first air gun. He is thought to have been alive about 125 BC and his *Pneumatica* contains detailed descriptions of almost a hundred small machines, including ideas for the double forcing pump and the stationary steam engine.

Evidence does indicate, however, that the development of the practical air gun as a small arm, designed to be carried by a man, did originate in Germany. The first specific statement of person, time and place, with regard to the invention, comes from a Nüremberg historian named Siebenkees. He states that

HUGE AIR WEAPONS

Immediately below is an 1885 Pneumatic Dynamite Gun that threw 100 pounds of the explosive about 2 miles. The bore was 8 inches in diameter and 60 feet long. The bottom photograph shows an improved version made in 1890. Its air charge propelled a 1000-pound shell containing 500 pounds of dynamite. Similar weapons were mounted on the U. S. Navy cruiser, "Vesuvius," during the Spanish-American War, but the fixed "tubes" were difficult to aim and scared the crew as much as the enemy.





a noted mechanic of the day, Hans Lobsinger, developed such an air weapon about 1560. There are many other claims to its invention, most notable of which are those made by the Dutch, French and Italians.

One weapon whose existence is very well known was Otto von Guericke's "Magdeburg Air Rifle," which was not a shoulder weapon but a small artillery piece. Its tube was mounted atop an air tank that was pumped up to pressure. (Von Guericke, who is given credit for the invention of the air pump, is perhaps most famous for his classic experiment in which two 6-horse teams failed to pull apart a halved copper sphere housing a vacuum.)

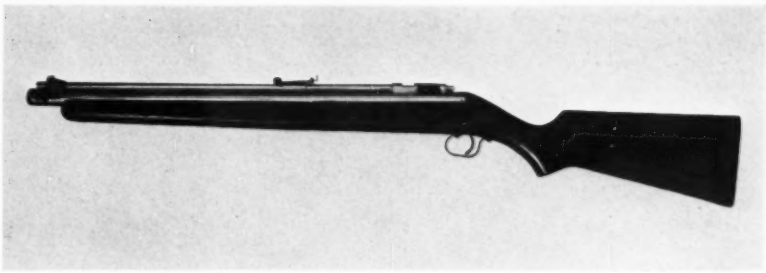
From the time of Von Guericke in the 1600's, air weapons have been continuously refined. Widespread manufacture began during the eighteenth century when some of the ideas that laid the groundwork for present-day mass production were introduced, one being parts interchangeability.

Probably the greatest use of air arms in war was in the first decade of the 1800's when they were turned against Napoleon. The rifle in use was designated the Austrian Repeating Air Rifle M. 1799. Initially it was a secret sharpshooters' weapon, but later was found to be so valuable for close fighting that 1300 men were organized as a special air-rifle corps. This particular gun had a caliber of .499 inch (12.8 mm), and a barrel length of 47.58 inches (122 cm). It had twelve rifling grooves and weighed 8.36 pounds. The action was brass; a cast iron or sheet metal butt was the air reservoir. A tube magazine on the right side of the receiver fed the bullets to the action, and a thumb-cocked hammer was fitted. When the trigger was pressed, the hammer fell forward, opening the escape valve that allowed air to rush forward and force the bullet out the barrel. Arming the weapon was no easy task—2000 strokes of a water-cooled pump were needed to compress the air in the flask to 400 psig.

These weapons were said to be effective to 400 paces; modern tests indicate that they are accurate at 100 yards, but nearly useless at 200. The gun was designed by an Austrian named C. G. Girardoni whose design was to be much copied. It is said that probably its chief use was psychological, for Napoleon, upon discovering the silent weapon was being used, issued an order that any enemy captured with one of the guns would be shot or hanged immediately. It is also suggested that the air gun had such an impact on Napoleon's soldiers that if he himself hadn't been present on the fields of Deutsch Wagram, during the battle on July 5-6, 1809, the French would have bolted.

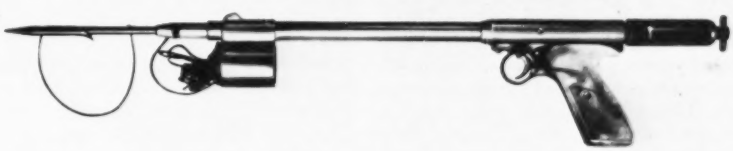
In American archives, one of the earliest statements about air guns is found in the records of the Lewis and Clark Expedition of 1804-6, published in 1814. No information about caliber or make is given, however. The first U. S. patent on an air gun was issued in 1862, although weapons even then were being produced in the country. Henry Marcus Quackenbush, who manufactured air rifles and pistols beginning in the 1870's, did much to further the utilization of air weapons from his factory in Herkimer, N. Y. He showed great business acuity by also patenting air weapon slugs and their manufacture. He followed up by licensing British and German firms to build his weapons and other designs he acquired.

(To Be Continued)



TWO MODERN RIFLES

The top picture is the Sheridan Silver Streak air rifle, manufactured by the company said to make the best pneumatic rifles in the world. This is a single shot, pump-type weapon. Below it is the Crosman Model 160 that uses a carbon dioxide cartridge for power. Many shooters prefer to pay for the gas cartridges instead of expending pumping effort.



UNIQUE GAS WEAPON

This deadly skin diver's sea gun also uses carbon dioxide as a propellant. The gas cartridge is behind the grip and the spear is housed in the barrel. A container near the detachable spear point feeds out line when a fish is impaled.

Sea Cow

Cantankerous "Animal" Has Grown Dependable

J. P. Smallwood

GONE are the days when it was necessary to approach the outboard motor with a fierce glint in one's eye and a starting rope hanging like a lash to tame the obstinate beast. John Steinbeck dubbed it a "sea cow" and wrote at length about its perversities. Today, the sea cow is no longer a mean piece of cast iron. The outboard that won't start is an exception rather than the rule.

Since World War II, vast improvements in carburetion and ignition have eliminated the last suggestion of unreliable performance. A marked improvement was the installation of forward-neutral-reverse transmissions. Seemingly overnight, the bulky and temperamental outboard won recognition as a quiet running, completely dependable power plant.

The men behind the cash registers in associated businesses reaped profits too. Boat manufacturers recognized a different customer in their showrooms. Bigger and better outboards meant that the family class cruiser gathered in a marked increased share of the skipper's dollar. Hardware manufacturers and designers found business brisk as demand for their products soared. In 1957, the water-ski trade was up 35 percent above 1956, and continued enthusiasm for that skittering sport is predicted.

Without a doubt, the most significant factor in the boating boom has been the economics of outboard motor manufacture. If the cost-to-the-customer of motors had increased relative to the cost of living index, many families now enjoying low-cost power boating would still be paddling or rowing. However, because of a constant attention to efficient manufacturing methods using the assembly-line principle and automation wherever possible, a motor costing $250, ten years ago, costs very little more today.

An excellent example of these streamlined methods can be seen at the plant of Outboard Marine Corporation of Canada, Limited, in Peterborough, Ont. There, as the photographs and captions on these pages indicate, the use of pneumatic tools, air cylinders and other penumatic devices are teamed with a wide variety of other up-to-date machinery and a modern materials handling system to the extent that this Canadian factory becomes a showplace of modern manufacturing techniques.

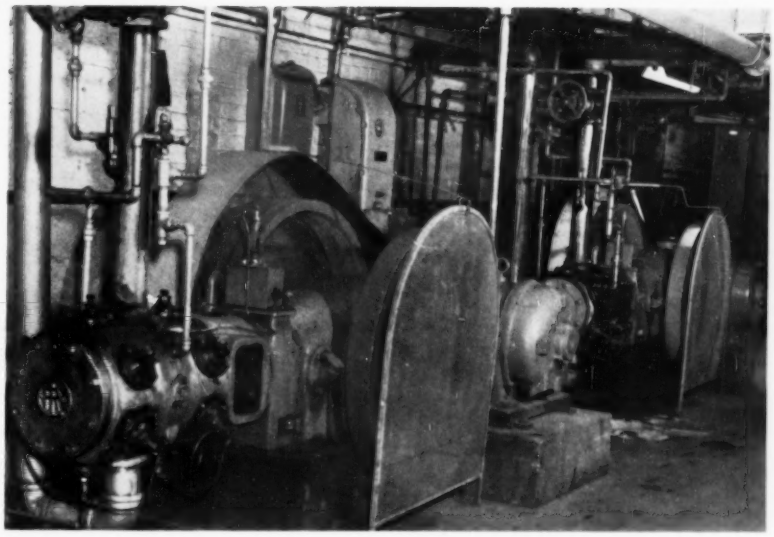
It is like being in the center of an organized beehive. From every corner of the eye, one can see some phase of the complex efficiency that keynotes the plant. Assembly areas resound with chattering tools, while above, engine components in various stages of manufacture glide quietly from department to department.

It all began when Ole Evinrude, generally credited with developing the first practical production outboard engine, founded Evinrude Motors in 1909. Five years later, he sold his business because of his wife's ill health.

Evinrude's first motors were bulky, frustrating and temperamental; as a result, outboard motoring did not become a fad. The first breakthrough in popularity came in 1921 with the Elto Light Twin Outboard designed by Ole Evinrude and manufactured by Elto Motors. This brought competition into the field, and the first Johnson Motor was produced in 1922. Johnson Motors had its parent plant in South Bend, Ind., and opened another at Peterborough, Ont.

IN ANTICIPATION OF SPRING

Low cost fun afloat is made available by efficient manufacturing techniques utilized throughout the outboard motor industry. The Outboard Marine motors shown are examples of how the small Evinrude motor will afford many hours of relaxation for the fishermen, left, or the water skier, below.



AIR FOR A PLANT

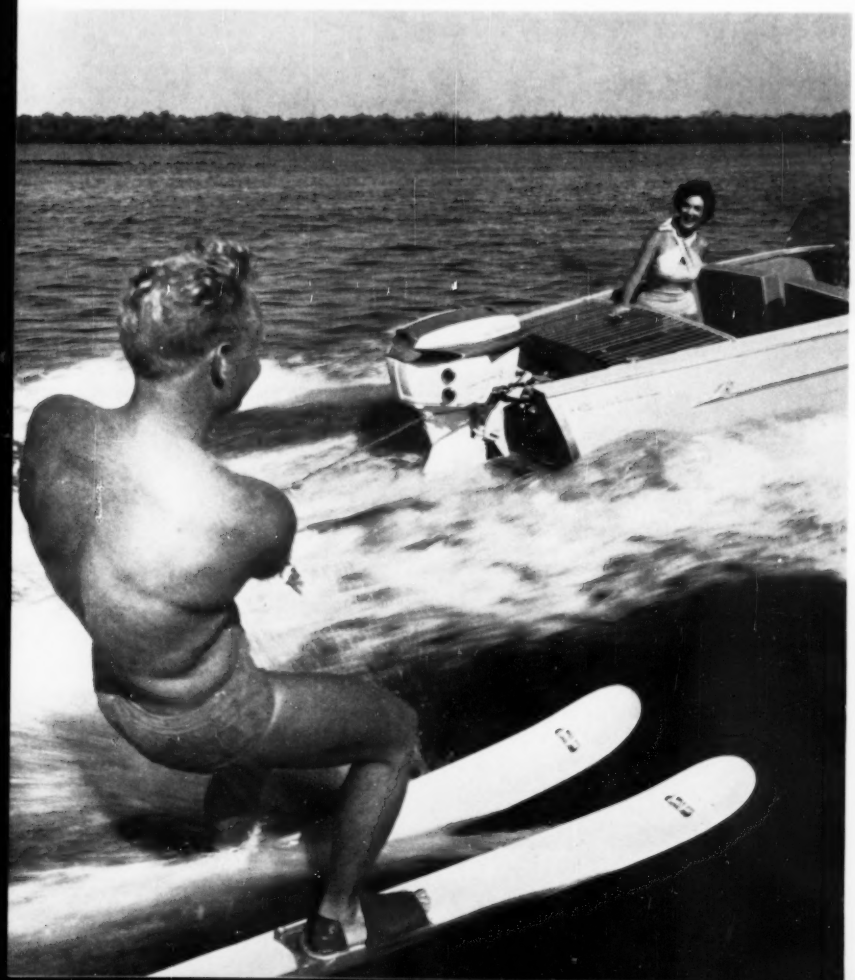
The heart of an efficient compressed air scheme is these two Ingersoll-Rand Type ES-1 compressors. Similar machines are spotted at various places throughout the plant near points of high demand.

In 1929, Stephen F. Briggs, who had an interest in Evinrude Motors, and Ole Evinrude, who owned Elto Motors, decided to merge. They also acquired another company, Lockwood-Ash, and formed Outboard Motors Corporation.

In 1936, Briggs, and Evinrude's son, Ralph, acquired control of Johnson Motors to form Outboard Marine Corporation. This aquisition brought together the Evinrude Division in Milwaukee, Wis., the Johnson Division in Waukegan, Ill., the Gale Products Division in Galesburg, Ill., (which had been started by Johnson in 1933) and Outboard Marine & Manufacturing Company of Canada, Limited, Johnson's wholly-owned subsidiary at Peterborough.

The operation at Peterborough, which had started in 1928 with about a dozen employees, soon had drastic adjustments to make as a result of the depression in the 1930's. The problem of shrinking export markets was met by placing increased emphasis on domestic business.

The outboard motor was taking shape as a completely reliable power unit in a nation with more fresh water lakes and rivers than any other country in the world. While many outboards were sold for pleasure uses, commercial fishermen, lumbermen and trappers became increasingly dependent on faithful motors. The result was that a firm market was established on the company's door-step. When Outboard Marine Corporation of Canada, Limited, was formed in 1936, production facilities turned out Evinrude and Elto Motors in addition to the Johnson line. This meant a faster production tempo.



Progress in outboard motor development was arrested with the outbreak of war. Outboard Marine Corporation was slated for total production of vital supplies throughout the war years, and it was 1945 before assembly was resumed on the outboard line. Back orders from war years poured into the Peterborough plant. Manufacturing facilities were strained to meet the soaring demands for motors. It was not until 1950 that an opportunity was found to enlarge the plant area.

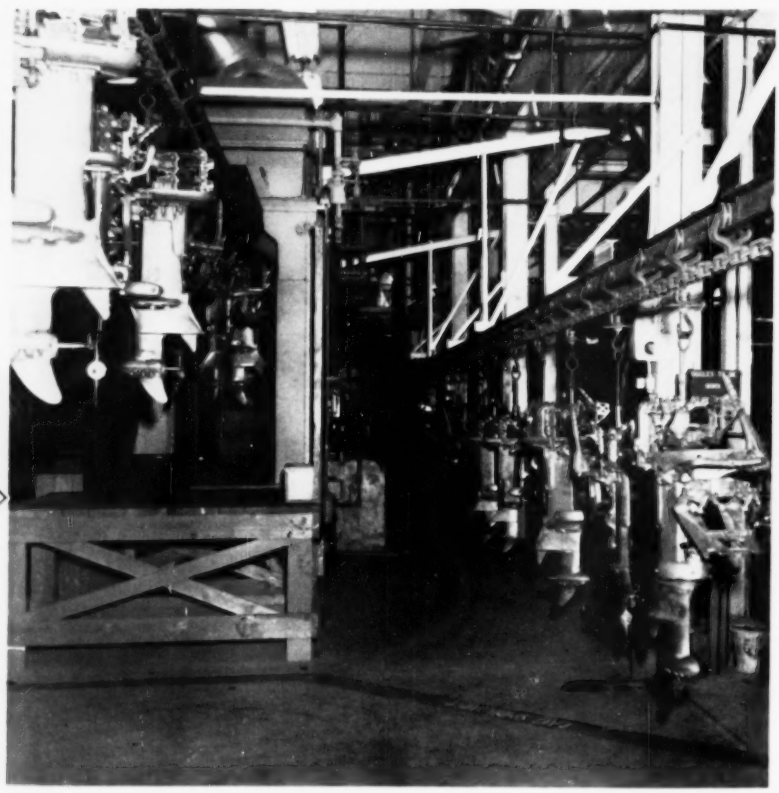
Meanwhile, sparked by demands for more powerful motors, quieter performance, better carburetion, remote control, positive ignition, efficient cooling, forward-neutral-reverse transmission and remote fuel supply, enormous technological progress was being made in the development of the outboard motor. With these technical refinements came new advances in high styling and eye-appealing color schemes.

Yet, even with the most carefully considered advance planning, it has been impossible for Outboard Marine to anticipate the rising tide of boating interest. During the last 5 years, in the outboard division alone, production has

doubled. Recently, $2,250,000 was spent for expansion. In 1957, 130,000 square feet of floor space was added to the Peterborough plant. This extension of the plant area is only one step in an over-all program in which several million dollars more will be expended before completion.

MAKING TIME-CONSUMING JOBS EASY

In the photograph above, the man in the foreground is operating a press powered by a Bellows air cylinder to accurately position connecting rod bearings for a 35-hp outboard motor. In the background, Hannefin and Air-Mite air cylinders are teamed to press in the wrist pin in a matter of seconds. Left is a picture of an operation that would ordinarily require several minutes — the assembly of a 10-hp outboard motor crankcase. Here, the operational time has been considerably reduced with an Ingersoll-Rand pneumatic screwdriver. Above the man's head is an I-R balancer that makes it easy to put the tool aside while at the same time it is readily accessible for the next job. At the edge of the workbench is still another use for compressed air — a hose and nozzle for cleaning-up operations.

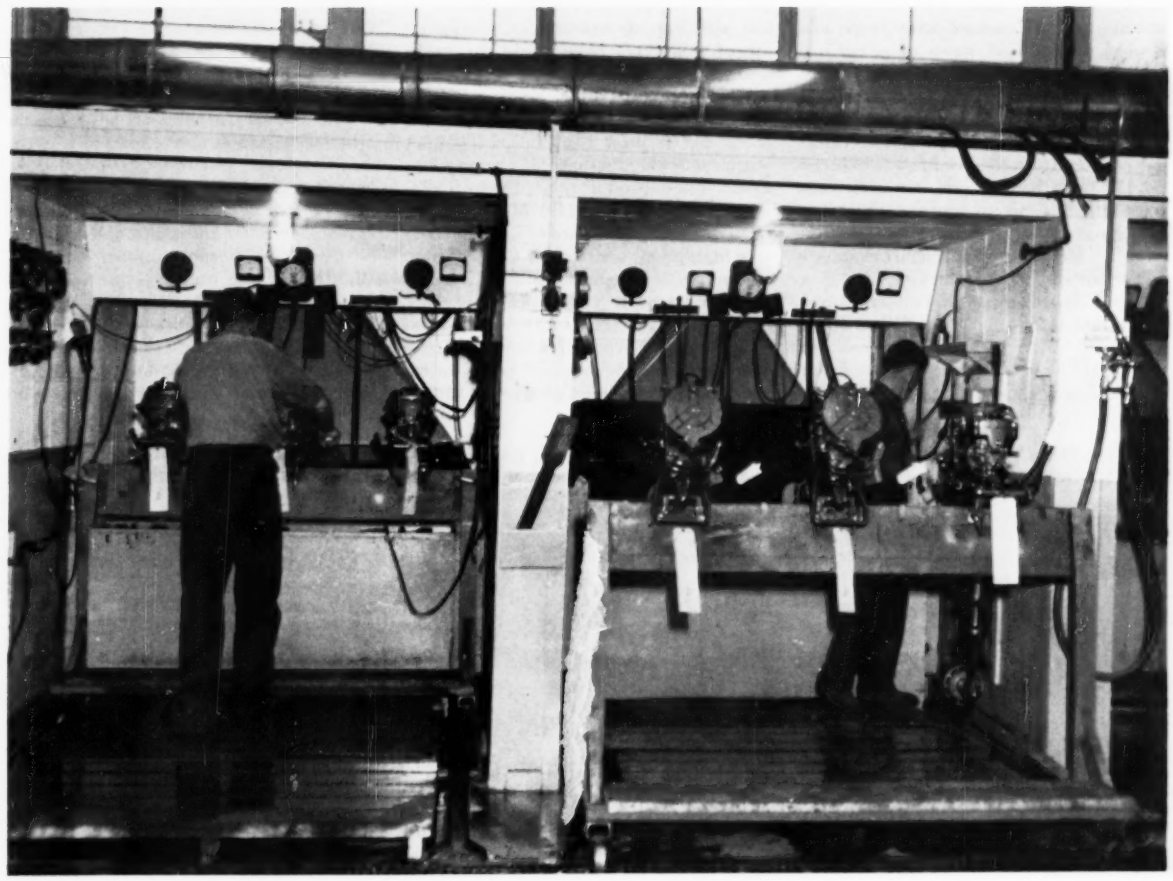


EASY TRANSPORTATION

To keep pace with the requirements of automation, elaborate materials-handling systems were installed. The motors in this view are nearing final assembly.

THREE AIR APPLICATIONS

In this view, an Ingersoll-Rand OB1N screwdriver is shown suspended, ready for use on the assembly of a 35-hp motor. The mechanic is using an I-R 5040 Impactool and in the tank of water to his left is the head assembly being tested for leaks with compressed air. Air is forced inside the units; bubbles indicate a leak.



TESTING

Before shipment, all the motors are tested at these benches. They are run in water to check revolutions per minute, and general functioning through their entire speed range. Sound is another indication of proper performance.

First Uranium Mill On Rockies' East Slope

Carey Holbrook

IN the development of uranium properties, and building of mills to process the ore, the west slope of the Rocky Mountains has commanded many headlines. The Four Corners district of Arizona, New Mexico, Utah and Colorado has been very active. Grants, N. M., not long ago a thin string of small stores along the Santa Fe, now has become a boom town with uranium stock certificates replacing the gold dust poke once characteristic of such towns. In Colorado, Grand Junction "eats and sleeps" uranium and many news stories about the precious element bear that town's date line. Such feverish activity as this on the Rockies' west slope has almost blotted out news of what has been happening on the east slope, where a quiet development has been underway for some time. This development is of high-grade uranium ore, a much different product from the low grade produced on the west slope, and an extremely more difficult one to process.

High-grade uranium ore was discovered in 1950 when Fred Schartzwalder's geiger counter started clicking at a spot about 8 miles north of Golden, Colo. Schwartzwalder almost starved to death before he could convince anyone that his strike was valuable, and he spent many hungry months seeking a backer. When he finally succeeded, his mineral holdings were organized under the name of the Denver Golden Oil & Uranium Company. The company has been producing high-grade uranium ore for more than 2 years.

Because no uranium mills were located on the east slope and because those operating across the divide were equipped only to process low-grade ore, Denver Golden has been compelled to ship its production more than 500 miles to Salt Lake City, Utah. During the past 2 years, it has sent 29,000 tons of the high-quality ore to a mill there. Transportation costs for this long haul, and the premium demanded for processing ore of this type, have made the profit margin a narrow one.

Although the Denver Golden mine is the largest producer on the east slope, there are at least twenty smaller ones within trucking distance of Canon City, Colo. These producers are in the Tallahasse Creek, High Park, Morrison and Boulder-Jamestown areas. To process this high-grade ore, Cotter Corporation, in July 1958, opened a 50-ton capacity pilot mill near Canon City.

In contrast to the usual uranium company, Cotter Corporation has only three stockholders and no stock has been offered to the public. There are no plans to do so. One of the three stockholders is the Malco Refinery of Roswell, N. M., headed by Robert O., and Donald A. Anderson. Malco is an independent company, refining and selling gasoline and its products to independent gas stations throughout New Mexico and adjoining states. Another major stockholder is The Wilson Oil Company, headed by Parker Wilson of Santa Fe, N. M., who is president of the Cotter Corporation. David P. Marcott, vice-president and general manager, is the third stockholder. In active charge of the concern's operations, he was formerly employed as a chemist by the University of California at Los Alamos, N. M., and has many years experience working with uranium, thorium and transuranic elements.

The Cotter Corporation is unique in other respects. It started not as a uranium developer, but was incorporated on March 1, 1956, under the laws of New Mexico, to implement a joint venture agreement with International Minerals & Chemical Corporation of Chicago, Ill. Its purpose was to acquire and develop thorium-bearing deposits tributary to an International-owned mill at Parkdale, Colo. After a time, Cotter's association with International was dissolved by mutual consent, but it proved

AFTER BEING DUMPED FROM LARGE TRUCKS, THE URANIUM ORE IS CONVEYED THROUGH MINUS 2-INCH AND MINUS ½-INCH CRUSHERS, AND THEN GOES TO TWO V-SHAPED ORE BINS WHERE . . .

to be a steppingstone to another venture. During the investigations for thorium, Cotter scientists discovered that more than a half-million tons of high-grade uranium ore lay in an area within trucking distance of Canon City. This led to the decision to build a uranium mill in a central location of this district.

Proceeding with the plan turned out to be more complicated than was anticipated. In September 1956, the company presented to the Atomic Energy Commission a plan for constructing a 50-ton pilot mill as a means of carrying on research and developing reserves in this district. Several hearings on the matter were held in Washington, D.C., with the Atomic Energy Commission, but time passed and no definite agreement was reached. Meanwhile Cotter had begun coöperative work with the Colorado School of Mines Research Department to develop a process for milling the high-grade uranium ore available in the area. After 14 months, a thoroughly practicable process was developed. This process is now used successfully in the Cotter mill.

During these months of planning the 50-ton mill, Cotter had made contracts with some twenty small producers to supply the mill with ore. The volume under contract convinced Cotter personnel that a small mill would not be able to handle the demands that would soon be made upon it. This information was taken to the AEC who suggested that Cotter present a plan for the construction of a larger, 200-ton plant. This was done late in 1957, and more hearings were held. On January 13, 1958, the Cotter Corporation received the ruling that construction of the large mill couldn't be considered. In order to take care of the producers under contract, the Cotter management decided to finance and build a 50-ton pilot mill without help from the AEC, but to possibly resume negotiations for the larger mill later. Construction began on April 23, 1958, and the first ore was processed early in July. When finished, the mill had cost nearly a million dollars in research, development and construction expenses. It is now working 24 hours a day 7 days a week and has 37 employees.

The construction of the mill itself is remarkable. Built by the Western-Knapp Construction Company, San Francisco, Calif., on a cost-plus basis, it was completed in 83 days. The cost was less than the estimate. Another unusual feature is the plant's source of water supply, a major factor in locating a mill of this type. The plant is adjacent to an old coal property, on which is located an abandoned 1100-foot-deep shaft. The shaft and the underground workings are filled with water that analysis found to be suitable for leaching uranium ore. The company has placed a large pump 600 feet down this shaft to provide an apparently inexhaustible water supply.

The ore treatment is a complicated process. After two grinders have reduced the ore to a minus ½-inch size,

Schwartzwalder's Saga

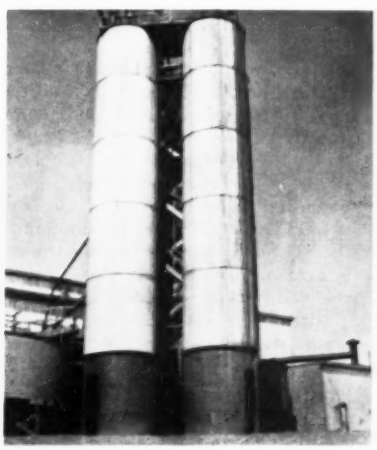
Fred Schwartzwalder's search for uranium on the eastern slope is a long tale of work, frustration and, finally, hard-won success. Young Schwartzwalder moved to Golden, Colo., about 35 years ago and was immediately caught by the spell of the Rocky Mountains. Through the years he accumulated a cairn of curious rock samples in his backyard, evidence of many hikes into the neighboring hills.

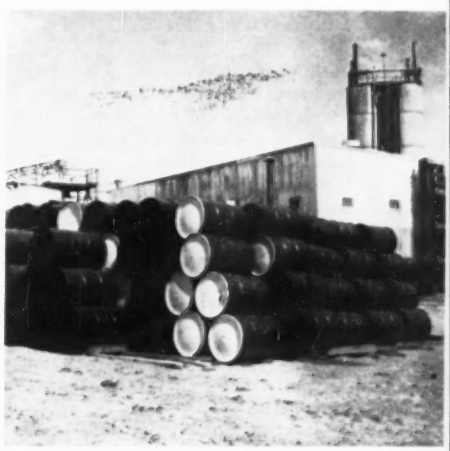
In 1950, he began to work overtime at his high school janitor's job to earn $100 for a Geiger counter. When the counter was finally his, he tested it on his backyard rock pile. The counter jumped wildly. Fred pulled the radioactive rock from the pile, only to realize he couldn't remember where he had found it. For 3 months he retraced his steps through the hills until one Sunday afternoon he came upon an outcropping on Indian Head Mountain. "The Geiger counter was as hot as a firecracker," he recalls. Fred rented the site from a rancher (promising him 15 percent of the ore) and began to dig in his long sought claim.

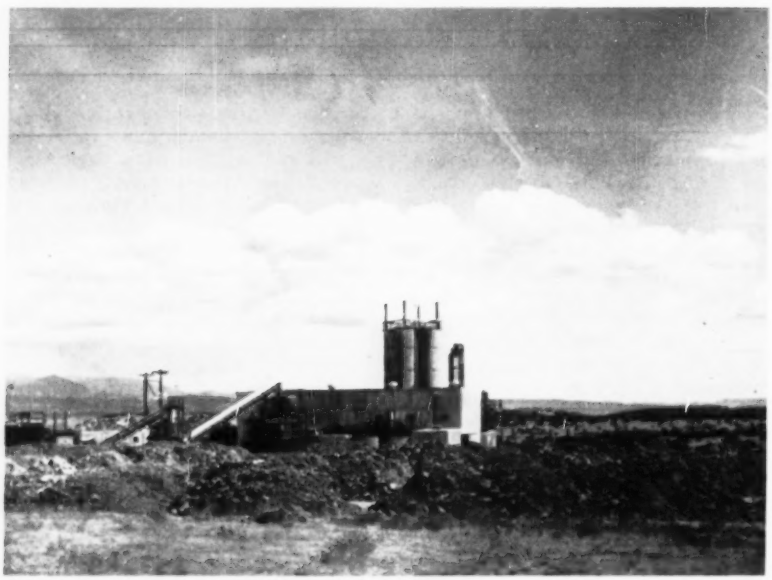
For 3 years he worked alone with hand tools. He knew little about mining practices. Even reaching the mine was a problem—everything had to be toted in the last 4 miles. Twice the mine entrance collapsed. Then, in July 1953, 70 feet back into the mountainside, Fred exposed a vein of uranium. "The Geiger counter went right up. I knew we had it."

But his frustrations continued: he was broke and couldn't pay to remove the precious ore. He even offered contractors half the profit to haul it, but they thought him another "crazy prospector." At last his son in California sent him $400, enough to pay for shipping 53 tons to Salt Lake City for processing. Three weeks later Fred Schwartzwalder received two $6000 checks from the AEC and a high-grade assay. Within a year the mine had returned him $125,000, and this was just the beginning. He was a rich man.

. . . IT IS FED TO THE MILL CIRCUIT FOR REFINING. FOUR TALL LEACHING TANKS CALLED PACHUCAS HELP IN THIS PROCESS, PRODUCING A YELLOW CAKE THAT IS STORED FOR SHIPMENT IN STEEL DRUMS.







URANIUM MILL

These two pictures show the Cotter Corporation uranium mill in its desert location. The chief features are the four leaching tanks and the two long conveyors that carry ore up to the mill building. Piles of high-grade ore to be processed are at the left in the aerial picture above, and are in the foreground of the picture, taken from ground level, at left.

these operations follow. The ore is introduced into the mill in a scoop box which feeds a 7x7-foot Marcy ball mill. There it is ground in a sodium carbonbicarbonate solution to approximately the grain size of powdered sugar. The ball mill discharge is classified by means of a Wemco spiral classifier. The undersize is fed to a Krebs 6-inch cyclone classifier, the oversize being returned to the scoop box.

Dry sodium carbonate is added to the circuit from a hopper, controlled by a Syntron feeder between the ball mill discharge and the spiral classifier. The undersize from the cyclone is discharged into the primary thickener; the oversize is returned to the grinding circuit.

The grinding circuit product is thickened to 50-percent solids and pumped into the first of four Pachucas (leaching tanks). The Pachucas can be operated either in a continuous circuit or on a batch basis. In these tanks, the slurry is held at 185°F and the uranium, in the tetravalent state in primary ores, is oxidized to the hexavalent state by the addition of oxidation air.

After sufficient time has passed to assure maximum extraction of uranium, the slurry is fed by gravity to the first of two drum filters. Here the solid material is separated from the pregnant solution which now contains all of the uranium values as a uranyl tricarbonate complex. The solids are reslurried with water and filtered on the second filter. The filtrate from the first stage of filtration is combined with the filtrate from the second stage.

The solid materials, or tails, are discharged to the tailing pond. The combined filtrates are further clarified in a clarifying filter and discharged into one of three precipitation vats where the uranium is precipitated as sodium diuranate. The sodium diuranate is allowed to digest at 160°F. The supernatant liquors are removed by decantation and the precipitate is filtered through a plate and frame filter. After repeated washings to remove entrained impurities, the sodium diuranate is discharged, in yellow cake form, from the filter into a repulper, then into a yellow cake drier, where moisture is removed and the granular material discharged into 55-gallon steel drums for shipment.

Continuous controls are utilized throughout the process. Moisture and head assays are made before the ore is introduced into the mill. In the mill, sixteen daily control samples are taken. In addition to these samples, the chemical laboratory must assay the final product for several specifications required by the AEC.

Further Expansion In British Columbia

British American Oil Company's New Refinery Is Helping Increase The Importance Of The Canadian West

Peter Sleight

BRITISH AMERICAN Oil's new Port Moody, B.C., refinery, which went on stream in October 1958, has a daily throughput capacity of 20,000 barrels—an amount equal to total Canadian crude oil production just 12 years ago. The facility brings British American's total crude-processing capacity to 165,000 barrels per day, and provisions have been made for doubling the new refinery's capacity. It is not the largest refinery in British Columbia, but it does include many engineering advances that are new to the Province.

The facility is situated among snow-capped mountains in one of the more historic places on the Canadian coast. It was here, for instance, that the first transcontinental Canadian-Pacific Railways train completed its run in 1886. The City of Port Moody is still officially listed as the end of the line, with that to Vancouver, B.C., rated as a "spur."

The modern refinery has been landscaped with 750,000 square feet of lawns to harmonize with its beautiful natural setting which was wooded and wild until B-A began construction work. In array are administration and technological buildings, tank dikes and most of the standard units that make up a refinery operation. The most noteworthy exception is the lack of a polymerization unit, the decision having been made to convert all cat-cracked propylenes and butylenes to alkylate.

In 1945, British American purchased Union Oil Company, acquiring land on Lulu Island, near Vancouver, with the intention of building a refinery at that location. After subsequent investigation, it was determined to abandon this property, and it was sold. The decision to buy land at Port Moody was made as far back as 1946. Originally it was planned to build the refinery close to Burrard Inlet so that salt water could be used for cooling, but surveys showed the land to be geologically unsuited for the construction so the refinery was moved farther up the slope, about a mile from the inlet.

Canadian Kellogg Company Limited, was named prime contractor for the construction in 1957. The massive program began with the moving of 1,000,000 cubic yards of earth to level the area; and today, the refinery is built on hillside terraces. Water is drawn from the City of Port Moody through some 20,000 feet of 10- and 14-inch pipelines. The capacity of this water system is 3,500,000 gallons a day—about twice the consumption rate of the present 3000 population of the City of Port Moody. Two 125-hp booster station pumps on the line help deliver the water to the refinery's cooling tower. At the station, circulating pumps have a capacity of 25,000,000 gallons per day, thus delaying the time before the facility will become inadequate through increased demands. Waste water is drained into Burrard Inlet.

Careful consideration was given to the prevention of the pollution of the inlet. Complete sewage systems have been installed throughout the refinery area. These include not only storm and domestic sewers, but oily water and foul condensate ones as well. The foul condensate is stripped of hydrogen sulphide and other contaminants before it is disposed. Oil collected in the oily water sewage system is largely removed by an API gravity-type separator. The relatively clean water is then passed to a holding basin, where the remaining oil is skimmed from the surface. The resultant clean water effluent is then passed through a 24-inch line, over a distance of some 320 feet, into Burrard Inlet. There, it is dispersed at a depth of 25 feet by means of a special diffuser.

In order to be able to keep a permanent check on any possible water pollution, a biological survey was carried out by a consulting scientist. A study was made of the existing water life, including even the 1-celled plants and animals, before the refinery went on stream. Checks are made periodically, and if there is any interference with this aquatic life, the source of the pollution can be traced and its severity correctly estimated. As an additional safeguard on this survey, other independent chemical laboratory analyses of Burrard Inlet water were made to determine the degree of pollution originally present.

To prevent air pollution, studies were made of the findings reported by other refineries, most of which are now undertaking extensive antipollution measures. From the data collected, an exhaustive report was submitted and used as the basis for the design of much of the refinery equipment. The most obvious example, to the casual observer, is the flare stack. Rising 249 feet and with a 42-inch diameter, it is smokeless.

All of these early considerations are examples of the meticulous care and planning that Kellogg and British American has put into the construction of the refinery—the largest single project ever undertaken by B-A since it was founded in 1906, and its sixth refinery. Equal care went into the choice of equipment and facilities; the new plant has firmly established British American in the era of electronic controls, better petroleum products and efficient operation. Many of the facilities are firsts, both for British American and British Columbia. The $25 million refinery, with its provisions for expansion emphasizes the determination of the company to grow with the air age, the west and the Province. As gasoline octanes increase, isomerization equipment will be added; the desulphurization unit has provisions for adding a stripper to provide feed for the isomerization unit.

Crude oil supplies for the refinery are drawn from western Canada through the Trans Mountain Pipe Line from Edmonton, Alta., to a tank farm at Burnaby, B.C. From there, an additional 2 miles of 12-inch branch pipeline has been constructed to the refinery.

With the aid of a 100-hp booster station, this branch line is capable of supplying the refinery with 80,000 barrels of crude each day.

At the refinery, the processing plant incorporates the latest processes and design features in its combination crude topping and vacuum tower, catalytic cracking, naphtha desulphurization and catalytic reforming, middle-distillate desulphurization, and alkylation units. (The alkylation unit, vacuum tower of the crude unit and the catalytic cracking section are described in the photographs that are reproduced on the following pages.) The naphtha desulphurization section has a capacity of 6000 to 7000 barrels per stream day, and uses a cobalt molybdate catalyst. From this section, the product goes to the catalytic reforming section where, using a platinum catalyst, it is reformed into high octane, low sulphur gasoline blending components. The catalytic reforming section can operate independently on low-sulphur fresh-feed stocks from storage.

The middle-distillate desulphurization unit, first of its kind for British American Oil and British Columbia, operates on 4000 barrels per stream day, using middle distillates from the combination crude topping and vacuum unit and from the catalytic cracking section. It removes sulphur, oxygen and nitrogen compounds. A cobalt molybdate catalyst is used, resulting in removal of 75 percent of the sulphur content of the Alberta feed stock, notably high in its sulphur content. This assures superior burning characteristics, color stability and resistance to sludging in heating oils, diesel fuels and stove oil.

Catalytically cracked gasoline is caustic treated through an electrical distillate treater to remove sulphur and phenolic compounds—thereby improving storage stability and clean-burning properties of the gasoline.

Knowing that modern gasoline users cannot tolerate the relatively uncontrolled blending methods of the past, the Port Moody refinery has an automatic blending facility. Thus, the essential need for the various components in a gasoline to be blended in exact proportions to assure top performance is achieved.

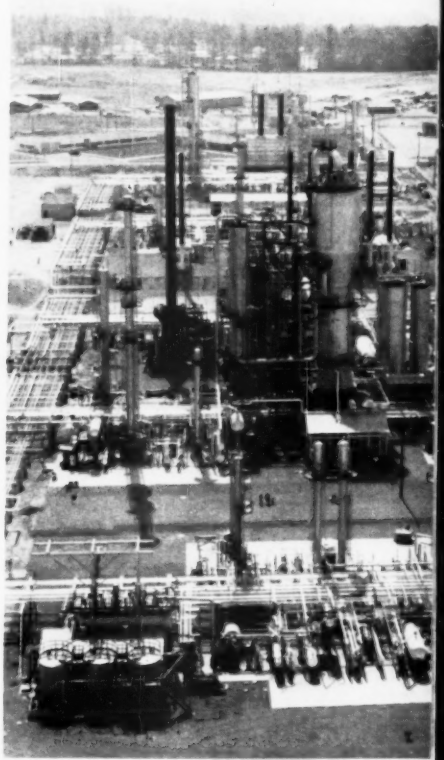
Taking advantage of recent developments in automation, the refinery is equipped with a complete electronic gauging system—the first such equipment to handle a complete refinery ever installed in Canada. Previous experience and past records have proved that the tedious task of gauging and reading temperatures of stored petroleum products by hand methods is no longer adequate. For this reason, British American is utilizing remote-control automatic-gauging facilities that permit the dialing of any tank to check quantity and temperatures of the stored product.

Electric power, another essential in refining operations, is delivered at a high 60,000 v to the refinery by British Columbia Electric Railway. It is reduced to 4160 v in a 7500-kva transformer. The monthly kilowatt requirements of the Port Moody refinery are equivalent to that needed for 10,000 average-sized homes.

British American Oil first came to British Columbia in 1935 as a marketer of petroleum products. It now has about 550 dealers and service stations throughout the Province, and a western headquarters located in Vancouver. Through the years, it has developed an important marine business as well, operating a large

Views Around A Refinery

WITH the help of a camera, we have been able to bring together scenes at British American's Port Moody refinery, not only as it looked when it went on stream, but as it did during the final days of construction. The pictures illustrate the role that air-powered equipment played in helping to make the refinery possible, and show some of the principal features at the facility.



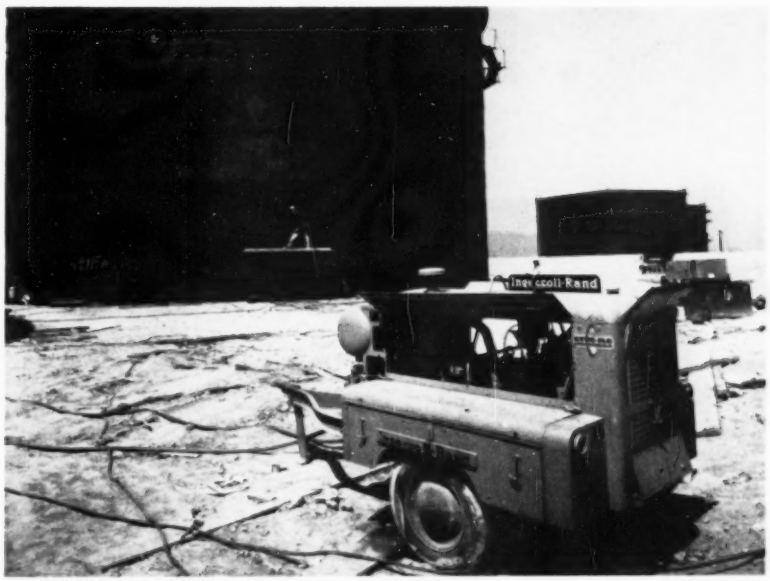
DURING AND AFTER

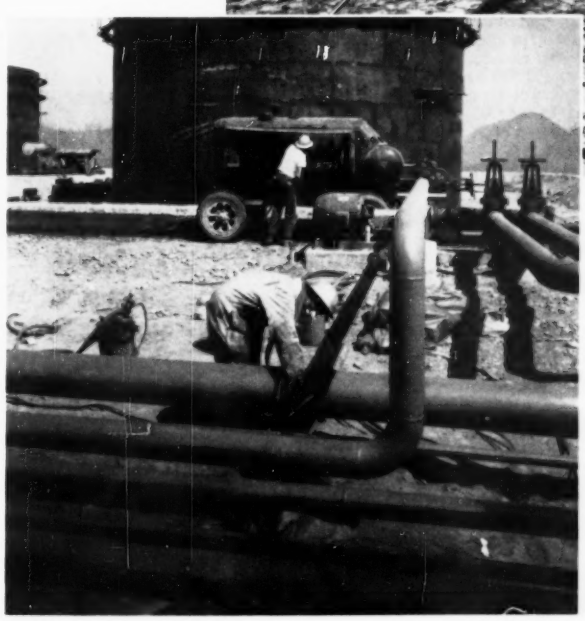
The illustration reproduced above was taken in May 1958, while Port Moody refinery was being constructed by Canadian Kellogg Company Limited. The one at the right was taken looking southward, or from the right-hand side of the first picture. During construction of the facility, wages paid to construction workers topped the $5,000,000 mark and brought considerable business to the small town of Port Moody. The completed tankage facilities include thirteen crude oil and gasoline tanks, capable of holding a total of 617,500 barrels of product. The majority of tanks have floating roofs to control evaporation loss and conserve the more volatile hydrocarbons. This assures retention of carefully selected blending components within the gasoline supplied to the customer, and prevents excessive light petroleum vapors from being released to pollute the atmosphere. Besides the production units there are an administration building, a cafeteria, an operations facility, a laboratory, a changehouse and a lunchroom.

tanker and several barges to serve the fishing fleets, lumber camps and other nearly inaccessible industries.

Located about a mile from the new refinery is the Port Moody Bulk Plant where lubrication oils, greases and drum goods of light oils are handled. This facility is housed in the old Canadian-Pacific Railway ticket office, near the B-A dock that was once used by sailing ships that carried steel to finish the railroad.

Besides the Burnaby terminal about a mile from the refinery, B-A also has another terminal at Coal Harbor to handle products for distribution to the Vancouver area and to British-American agencies and distributors. The new Port Moody refinery and its allied activities clearly show an important step forward for B-A's British Columbia development, underlining the company's confidence in the future of the Province. It not only has developed new markets for British American, but has revitalized its previous claim of serving all the provinces and territories of Canada. Constantly increasing octanes and expanding demands are not likely to make this refinery obsolete in the near future.





THREE SOURCES OF AIR

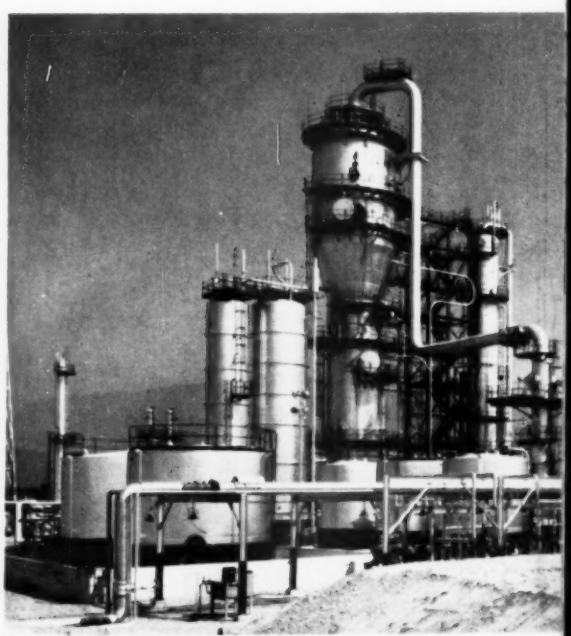
In addition to the other air-supply units, these three portable compressors were also used to good advantage. The one at the top is a GR-125 and provided air for construction and finishing touches on the products tanks. (The man in the background is using an air-operated chipping gun to finish that unit.) The portable compressor, directly above, is a DR-315. At the time the picture was taken, it was supplying air for operating a vibrator to consolidate the foundations of a trench. The third portable unit (left) is an early-model reciprocating GK-210 Canadian Ingersoll-Rand compressor. It supplied air at a pressure of 100 psig for painting oil lines.

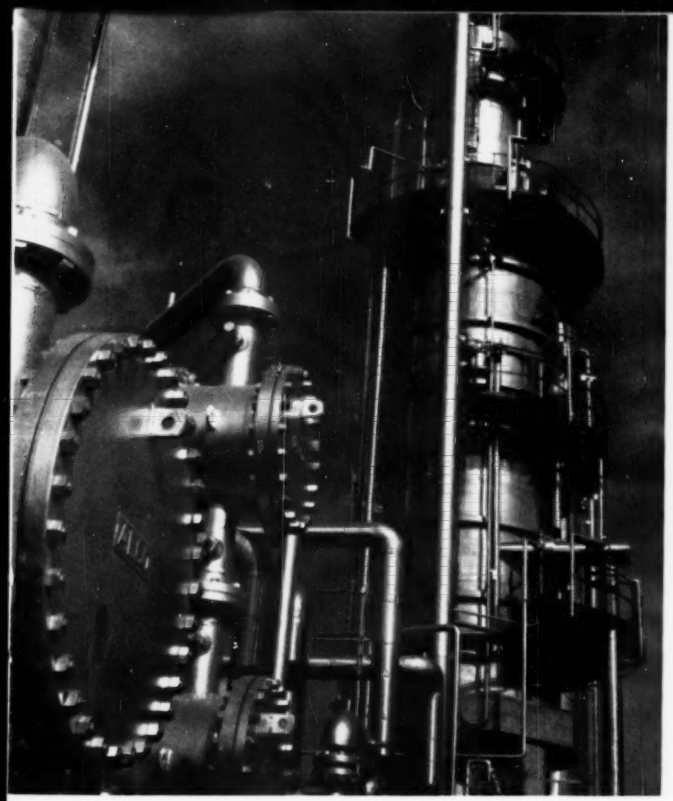
FLARE STACK RISES

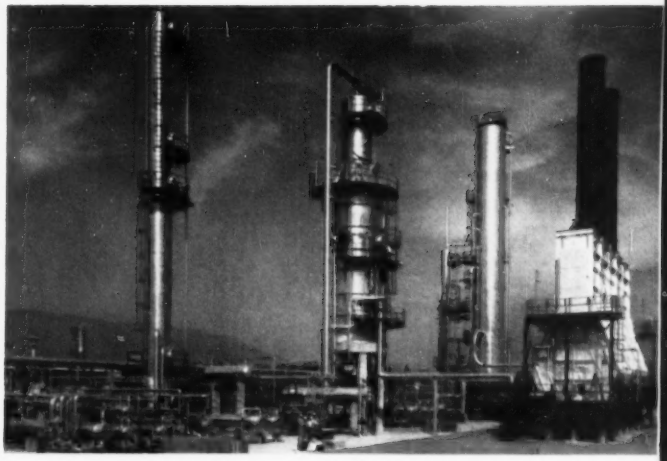
Standing in front of the rigging required for the erection of the flare stack, this Ingersoll-Rand DR-315 Gyro-Flo rotary air compressor furnishes air at a pressure of 100 psig to several air-operated hoists. One of these is seen in the illustration above. It is an HUL utility hoist. The completed stack rises 249 feet and is smokeless.

CATALYTIC CRACKING UNIT

The Orthoflow "B" Catalytic Cracking unit is the second of its type installed by British American Oil — the first having been at Clarkson in 1954. The regenerator is mounted over the reactor, instead of vice versa, resulting in capital and operating savings. The unit is capable of converting 9000 barrels per stream day of gas-oil blend received from the combination crude topping and vacuum unit. It is said to be able to handle as much as 14,000 barrels a day, total reactor feed including recycle. The cat-cracker utilizes a 26,400-cfm Ingersoll-Rand air blower rated at 19.7 psig. It is driven by a turbine at 5200 rpm. A centrifugal gas compressor, also of Ingersoll-Rand manufacture, is utilized to furnish air at 3270 cfm at 195.3 psig. The latter is driven at 10,000 rpm by a 1347-hp turbine. In this illustration, the unit at the right is a carbon-monoxide-fired boiler. It has a capacity of 85,000 pounds of steam per hour and about 30 percent of its Btu requirement is obtained by burning catalytic cracker stack gases that would otherwise be wasted. It is the first boiler of its type installed in British Columbia, although B-A has a similar unit at its Montreal refinery. Operating pressures of the boilers are the highest at any of the B-A refineries. A second high-pressure boiler is in use and is of the conventional type, producing 81,500 pounds of steam per hour. Together they have a total capacity of 166,500 pounds of steam per hour at 625 psig and 750°F.

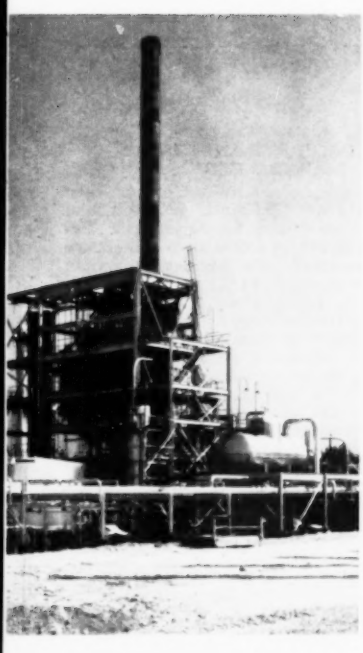






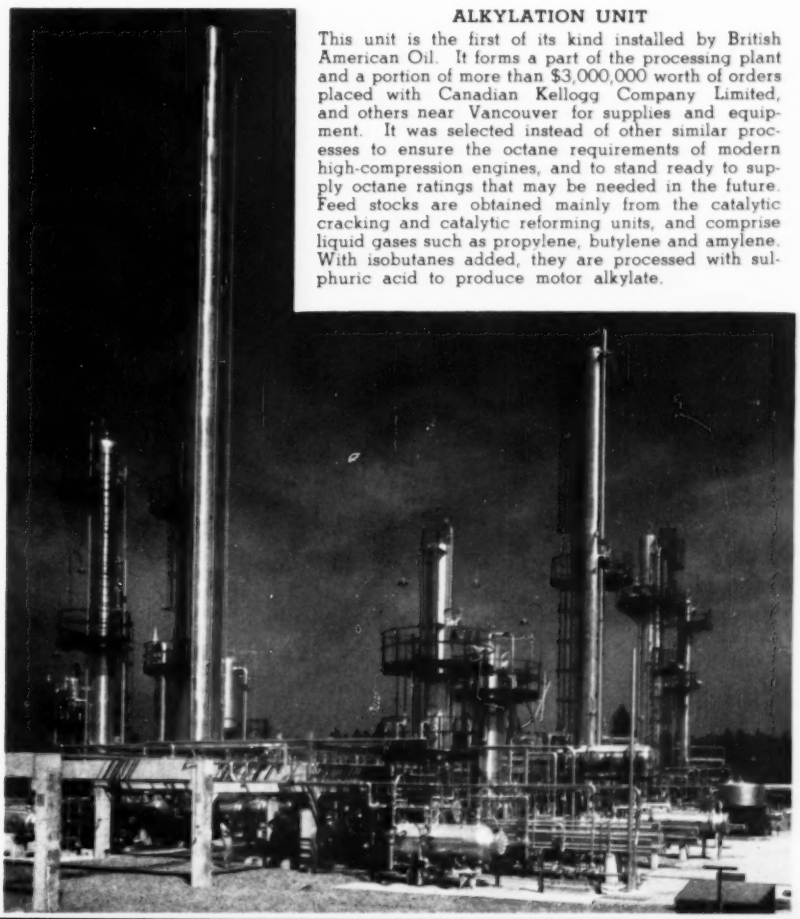
VACUUM TOWER OF CRUDE UNIT

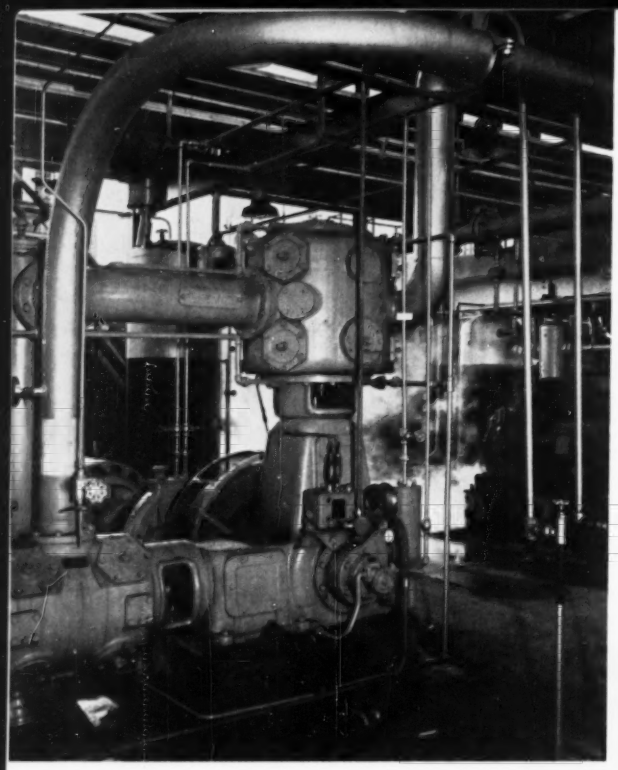
The crude topping and vacuum unit has been designed to process 20,000 barrels per stream day of western Canadian crudes. Products yielded from the combined unit include gas, a 380-EP gasoline, kerosene or stove oil, diesel oil, atmospheric and vacuum gas, oils and residuals. The unit is designed to operate independently when adjacent units are shut down. Above is an over-all view of the crude unit where oil is separated into various fractions, and at the left is a close-up view of the vacuum tower. Prior to charging to the crude topping and vacuum unit, all crude oils are treated in a chemical desalting unit. It is reported that the removal of organic salts is 95- to 100-percent complete.



ALKYLATION UNIT

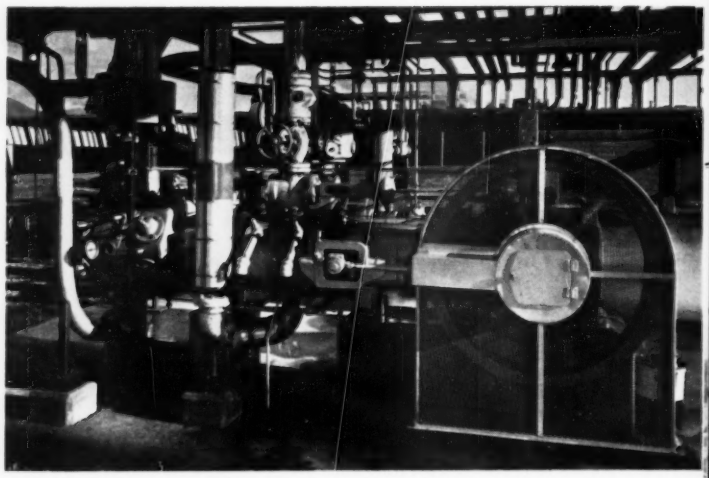
This unit is the first of its kind installed by British American Oil. It forms a part of the processing plant and a portion of more than $3,000,000 worth of orders placed with Canadian Kellogg Company Limited, and others near Vancouver for supplies and equipment. It was selected instead of other similar processes to ensure the octane requirements of modern high-compression engines, and to stand ready to supply octane ratings that may be needed in the future. Feed stocks are obtained mainly from the catalytic cracking and catalytic reforming units, and comprise liquid gases such as propylene, butylene and amylene. With isobutanes added, they are processed with sulphuric acid to produce motor alkylate.





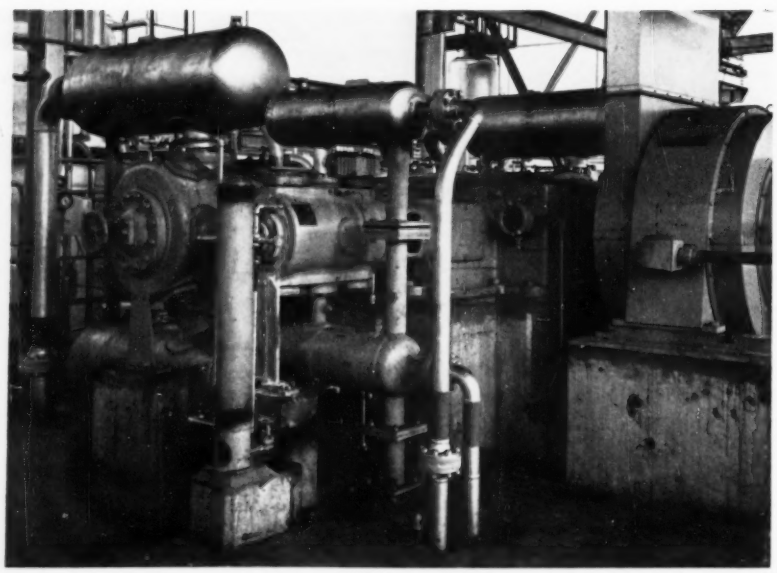
PLANT AIR SUPPLY

Air for the plant on Burrard Inlet is furnished by this Canadian Ingersoll-Rand 15&9x8-inch, Model XVH-2 compressor (left). Its delivery is rated at 685 cfm at 110-psig pressure. A 150-hp Westinghouse induction motor drives the unit at 514 rpm through a Falk reduction gear. The system has dual control regulation with 3-step clearance control.



INSTRUMENT AIR

An Ingersoll-Rand 12&14x11-inch, Model FSH-1-NL-1 compressor (at the right) is driven by steam at 360 rpm. Because it is used for instrument control work, the air must be clean and free from all oil particles. Therefore, a non-lubricated unit was selected, featuring carbon piston rings, aluminum pistons, "A" Channel Valves with carbon guides and Du Pont Teflon wearing strips. It is equipped with a Model 28 PL-12 (pipeline) aftercooler, also of Ingersoll-Rand manufacture. The unit has a capacity of 458 cfm of free air when developing 110-psig pressure. With constant speed control, required steam pressure for operation is 160 psig.



PRODUCT AND GAS RECYCLE SERVICE

In the photograph at the left can be seen a 12 3/8&12 3/8&5 1/4x12-inch Ingersoll-Rand 3HHE-1-1 compressor for recycle gas service. It is driven by a 600-hp Westinghouse synchronous motor, and handles (1) product from the catformer and (2) gas recycle from the naptha desulphurizer. In the former operation, the two large cylinders are used, in the latter, the small (5 1/4-inch) one is required. Discharge from the 12 3/8-inch cylinders ranges from 461- to 473-psia pressure, with the inlet at a constant 328-psia pressure. On the desulphurizer cycle, the inlet is constant at 456-psia pressure and the discharge is also constant at 531-psia pressure. The cylinders are arranged, as shown, with one 12 3/8-inch and the 5 1/4-inch cylinders on one side; the remaining 12 3/8-inch cylinder being on the opposing side.

This and That

Tighter Gauge Block Tolerances

Gauge blocks are mass produced in a remodeled and expanded metrology department at The DoALL Company to standards that even a decade ago would have been considered laboratory curiosities. Gauge block manufacture starts in the plant along with other precision work. They are machined, carefully heat-treated and stabilized. Because the special stabilizing process requires a lower temperature than is possible to obtain with standard equipment, a 3-stage unit was installed. It provides a minimum temperature of minus 180°F and sufficiently rapid heat transfer to completely stabilize the blocks. After stabilizing, the blocks are then accurately ground to within a few thousandths of the finished size. At this point, they are taken to a controlled-environment area for finishing. Here the dirt particles in the atmosphere are reduced to a minimum. To further assure this clean atmosphere, personnel entering the area must pass through two air locks where a water jet and exhaust air system remove the lint and dirt, passing it through a floor grating. The return air is exhausted into the air locks and out through the floor grate, where a water spray traps the dirt and disposes of it. (The water spray operates only when entering, not when leaving.) The temperature and the humidity of the area are also closely controlled, as is the barometric pressure. In this controlled atmosphere, Grade B gauge blocks have been eliminated from the DoALL line, and the cost of producing greater quantities of Grade A blocks has been reduced.

* * *

Skin Divers Now Act As Loggers

Because of expense necessary to produce and cut lumber in the Canadian forests, logging concerns have solicited the aid of a different type of logger—the skin diver. On their watery route to processing mills, many logs are "sinkers"—they become water-soaked and fall to the bottom. In the past, according to the Newsprint Information Committee, a group of Canadian newsprint producers, these sinkers were ignored because their recovery cost was more than the logs were worth. Now that prices are higher, salvage is often feasible, and skin divers do the work. They swim in depths of 20 to 120 feet and carry on their backs two tanks containing 140 cubic feet of precious compressed air, enough for 70 minutes of work at about 30 feet. They wear rubberized canvas swim outfits and gloves to protect them from the chill water, and the usual rubber flippers and face masks. When the sunken timbers are found, the diving crews loop half-inch cables around them, and a winch on a raft pulls the logs to the surface. A good crew can salvage 12,000 board feet a day at an expense of about $15 a thousand board feet; the logs usually cost about $34 a thousand feet. Water doesn't seem to hurt the wood, even though the sinkers may stay immersed for several years. Lumber isn't the only harvest the skin divers make, rivers and lakes being the receptables they are. Tools lost during logging operations are found—peavies, chains, and even such large equipment as tractors and work boats. Occasionally, the body of an unfortunate logger lost during the hazardous lumbering operations is recovered. The skin divers carry spear guns and use them for protection as well as for adding fish and other sea food to the camp larder.

* * *

Era Crumbles, Crumbine Cup Comes Home

A hand-wrought iron drinking cup, probably the oldest common drinking cup in America in continuous use, has found a permanent home. The cup was chained to a granite rock at a spring near Fort Scott, Kan., for more than 100 years and has now been presented to the Kansas State Historical Society Museum at Topeka. Several years ago, after its life of serving cool drinking water to wagon train settlers, Civil War troops, Indians and community residents, the cup was presented to Dr. Samuel J. Crumbine. Dr. Crumbine was a frontier physician and a leader in the campaign to replace the common drinking cup with the sanitary paper cup. In recent years the cup, symbol of a nostalgic but less sanitary era, has been on display in the offices of the Paper Cup & Container Institute in New York City, which gives an annual national "Crumbine Award" to state and local health departments. The pioneer physician died in 1954, and his daughter recently presented the cup to its home State's historical society.

* * *

Detroit Firm Fits Workmen To The Job

Compressors at a large midwest plant were recently found to be taking in sand that was causing the machines to foul. The company was nearly prepared to begin the expensive task of digging up the 18- and 24-inch diameter air inlet lines to find the trouble. However, before the time-consuming excavation began, the company called upon the Midget Service Company of Detroit, Mich. This firm provides small, but expert, repairmen who can inch their way into tight places to get at work. Their ability eliminated the need for digging—the men were able to crawl the entire length of the air lines. They found the leaks and repaired them from the inside. Now the Midget Service Company's men make regular internal tours of the air lines as part of the preventive maintenance program.

* * *

Manual For Satellite Observers

A simplified method of predicting satellite courses has been published for the benefit of volunteer observers by the National Academy of Sciences. With this do-it-yourself manual, volunteers can utilize simple orbital elements, such as the inclination of the orbit plane to the equator and the distance to the center of the earth at the low point of orbit, to figure where to look for artificial earth satellites in any given locality. It is said that predictions on the basis of the manual will, in many cases, be useful for a period of a week or more. For those who are using the manual, the only major computing consists of long division. After placing the orbital elements on a form that is provided, the observer goes through the calculations outlined, step-by-step. These enable him to find the orbit plane, and then the longitude where the satellite will cross his latitude. Additional calculations will allow the observer to determine the position of the satellite as viewed from his location.

* * *

Photographic Finding Of Lost Parts

Those conduits, junction boxes and pipes that are "lost" by having their locations changed during construction alterations can now be found. A company in St. Louis, Mo., Photo Perspective Corporation, has applied the principles of aerial surveying photography to the job of finding the construction elements that depart from the blueprints. This method saves many hours of wasted labor and many dollars worth of torn-out walls and floors that often result when various lines and boxes are altered. The first step in the system is to divide a partially constructed building into the 20x20- or 20x40-foot sections that are worth recording for later reference. A surveyor's level is attached to a camera and a master grid on the lens cuts the sections into rectangles of equal

area. The camera is stationed 20 feet behind the midpoint of line 0 of the grid; the camera is 5 feet above the finished floor. When the print is made, the grid lines appear superimposed upon the picture. Supporting columns can be marked so that each bay in the photo may be identified with reference to the blueprint. Photo Perspective Corporation recommends the use of a 4x5 press camera. These grids are made for 127- and 135-mm lenses. The 4x5-inch negative is used to make 11x14-inch enlargements.

★ ★ ★

Filtering Floating Fallout

A simple method for collecting radioactive particles in the upper atmosphere for subsequent measurement is possible with a superfine fiber filter developed at Stanford Research Institute, Menlo Park, Calif. Radioactive particles floating to earth are not the only fallout problem. Many of these little-studied bits of matter are so small (less than a micron—0.025 inch) and light in weight that they remain suspended in the upper atmosphere. Filters for collecting the particles have been available for several years, but making them has required complicated and expensive equipment. The high purity and nonmetallic organic character of the new filter facilitates accurate measurement of the radioactive particles. The filter can be completely burned away, leaving the radioactive residue for analysis. The device is made by spraying a solution of polystyrene in methylene chloride solvent through a fine nozzle. The solvent evaporates almost instantly, leaving thread-like fibers less than 1 micron thick and 1 inch long. The fibers are directed by the spray force against a 2-foot square of Dacron mesh, vertically mounted about 4 feet from the spray nozzle. They build up into a filter mat. The superfine filter has a very high collection efficiency (it retains 99.5 percent of the particles it picks up) but has a reasonably low resistance to air flow. The technique was developed for the USAF Cambridge Research Center.

★ ★ ★

Atomic Blast Simulated In Vessel

A device has been perfected that permits engineers to test materials by subjecting them to the explosive force of an atom bomb, but without use of radioactive materials and all their accompanying problems. The unit, located at the Naval Civil Engineering Laboratory at Port Hueneme, Calif., consists of a 20-ton steel pressure vessel. It is approximately cylindrical in shape, mounted on top of a 75-ton heavily reinforced concrete pier. Engineers place the item to be tested, such as a steel structural beam, inside the steel shell. A firing tube, also contained in the shell, is loaded with enough Primacord explosive to produce the desired blast. (Primacord is a high-velocity explosive that is produced in cord form, similar in appearance, and appearance only, to ordinary fuse.) The simulator can reach pressures of 20 to 185 psig in 1 to 2.5 milliseconds. A description of the apparatus is contained in a paper written by W. W. Boynton, director of Boynton Associates of LaCanada, Calif., the company which designed the unit. The paper was delivered at the December 1958 meeting of the American Society of Mechanical Engineers in New York City. The test vessel is officially known as an Atomic Blast Simulator but because of difficulties encountered in building it, workmen named it the "Trojan Horse." Navy engineers refer to it as the "Boyntonsaur" in honor of its designer.

★ ★ ★

Friendly Flying Saucers

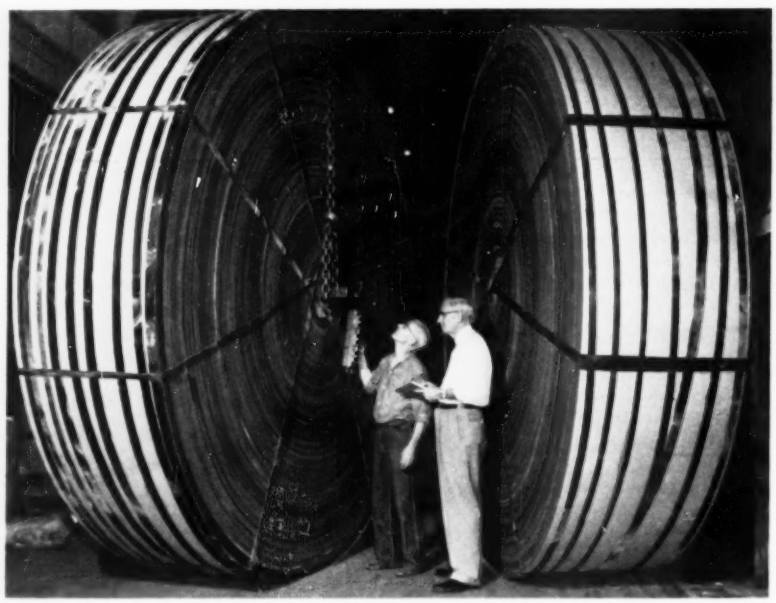
Having always had a sympathetic feeling towards stranded troops, explorers and hunters, we were please to read of flying—or more accurately, falling—saucers that may be able to help them. They are 30 inches in diameter and are made of rubber. Each saucer has a capacity of 5 gallons, they may have oil-resistant liners for petroleum, or rubber ones for water. To date, test drops have been made from as high as 2000 feet without bursting them.

★ ★ ★

Stimulating Science Studies

Planet Earth is a unique teaching aid designed to meet, in part, the critical need for stimulating science interest in the schools. Conceived by the National Academy of Sciences, it details the scientific fields studied during the just-ended International Geophysical Year. There are three major components. The first includes six large, full-color posters entitled "The Earth," "The Oceans," "The Poles," "Sun and Earth," Weather and Climate" and "Space." The second component is a profusely illustrated, 44-page Student Brochure that reproduces the posters and describes the work of scientists in a dozen or more fields. The third is a Teacher's Kit containing suggestions for classroom experiments, background material on aspects of the IGY and the earth sciences, a description of teaching methods related to the IGY in the Baltimore (Md.) County schools, a list of scholarships available to students in the field of science and other materials.

ONE MILE OF BELTS



Two employees at Goodyear Tire & Rubber Company are dwarfed by 1 mile of conveyor belting. Shipped by railroad, the belting had to be transported by a special route because of the height of the rolls. More than 12 feet high and weighing 13 tons each, the two rolls are part of an order for a mechanization program by Ash Grove Lime & Portland Cement Company of Louisville, Neb. The 36-inch-wide belts will be spliced together for a ½-mile haul of limestone from quarry to mill at a rate of 1000 tons an hour.

EDITORIAL

Technology

SCIENCE, in our day, is growing increasingly dependent on technolgy. Webster defines the word as the "science or systematic knowledge of the industrial arts." Others prefer a more complex definition: to this group, technology is identified with the relationship of man to his labor, capital, techniques, tools and even his dreams.

However defined, technology is certainly the difference between savagery and civilization — the means to an end must necessarily precede its fullfillment. Man, himself, has always been a technologist. Although he has made and used tools from the time he emerged as a distinct species about half a million years ago, he was nothing more than a migrant food gatherer and hunter for 98 percent of his era. He lived to eat and to procure food. Only in the last 2 percent of the age of man did he become first a farmer, then a trader, a builder and a scientist.

WHEELS, levers and inclined planes are things familiar to all of us. We cannot visualize a way of life without them. The men that devised these first tools were the geniuses of their age. Scientists and engineers have paid vocal tribute to them. Economists, too, are greatly indebted to the same men for within their minds were the first faint glimmerings of the concept of capital. Each had invested his time and effort in a project that did not immediately put food into his belly. Instead, work was expended to make an article that in the future would enable him to fill his stomach more easily. He had made a capital investment.

INNOVATIONS in science, history shows, come in spurts, rather than steadily. The basic theories that have enabled us to push back the frontiers of science require time to grasp. Technology, in Webster's sense, progresses more evenly. Indeed, its gradual persistent use of the "hardware" based on abstract theories may help considerably in quickening the grasp of the theory itself, and in that way paving the way for new and significant advances in the realm of pure science.

TECHNOLOGY is the servant of all and a benefactor as well. In the United States, it has resulted in the highest standard of living ever attained by man.

If technology has brought its benefactions, it has also brought its problems. Our agricultural crop surplus is a result of expanding technological aids to the farmer. Air and water pollution are outgrowths of the rapid pace of industrialization. The United States builds and its citizens own more automobilies than all the rest of the world, but our highways are congested and parking in some instances seems nonexistant. The very advances designed to produce more and better products for less money sometimes cause dislocations of workers. Similar changes result in obsolescence of equipment before it is worn out. Some authorities insist that although these problems and many others are symptoms of the expanding technology, there is not a direct cause and effect relationship between them. They suggest that our social and economic growth may not have been fast enough to keep up. They dream of a day when the money spent on the technology of war may be devoted to the technology of peace. Certainly with the medical, agricultural and physical advances we have made, the goal of the elimination of human starvation and suffering is within reach.

Be it that the problems exist because of, or in spite of, our burgeoning technology, it is certain that most men look to continued technical advances to solve them. Great progress has been made in ending air and water pollution. Central city rehabilitation schemes promise an end to slum areas and the provision of adequate parking. A great highways program is now underway to make future travel easier and safer. The entire labor force is gradually being upgraded in skills to operate the new and complex machinery of our age.

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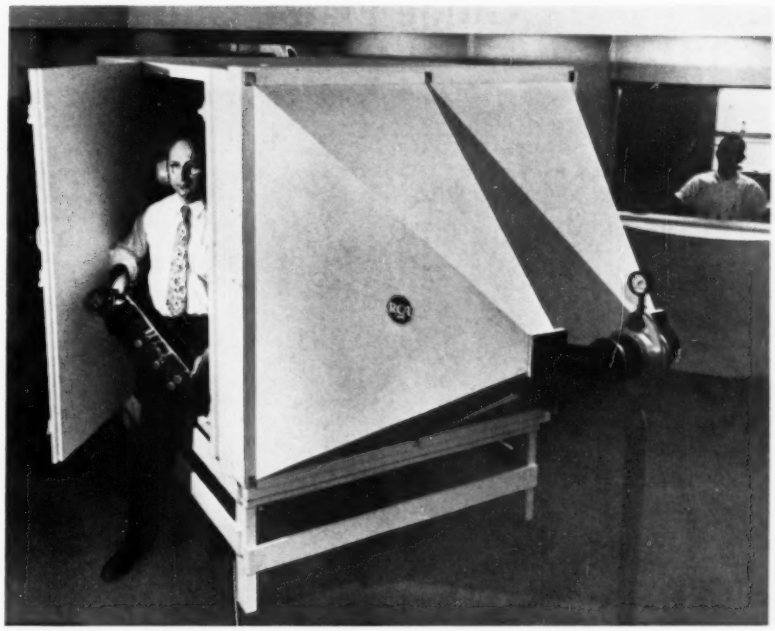
YOU CAN BE SURE...IF IT'S Westinghouse

Controlled Sound Of 160 Decibels

THE SPACE age promises to force extreme conditions of acceleration, velocity, temperature and pressure on both man and his machines. Another by-product of the new age that is becoming evident results from the intense noise vibrations of jet aircraft, missiles and rockets.

To help learn about these shudderings, Radio Corporation of America engineers at the company's Industrial Electronic Products unit in Camden, N. J., are developing a compressed air loudspeaker to generate 160 decibels of controlled sound. The machine, now in the development stage, will produce noise for testing electronic and mechanical equipment. Such equipment reacts to high sound levels much as humans do: when humans are subjected to violent noises, more than the ears suffer—painful body vibrations can become unbearable. Electronic and mechanical instruments suffer from this violent buffeting in the form of shattered delicate parts. Even before they fail, these parts will often perform improperly for a time. An example would be an altimeter not built to withstand a high sound level. When subjected to violent noises, the instrument may function improperly and give the pilot a false reading.

The RCA air loudspeaker is a plywood box, 5x5x6½ feet, with two horizontal, pyramid-shaped horns projecting from it. Attached to the tip of each horn is a metal pipe leading to the loudspeaker's air supply. The speaker box is enclosed, and electronic or mechanical devices to be tested are placed inside before the sound is produced. The 160 decibels of noise that the horns emit is described by the engineer in charge of the project as being more than 10,000 times as intense as the loudest street traffic. A television set adjusted to its highest volume, then multiplied by 20,000, is another comparison.



VIBRATION-TESTING A RADIO

A. L. Witchey, RCA engineer in charge of developing the compressed air noise-maker shown here, removes a radio that has just been subjected to 160 decibels of sound and the resulting intense vibration. Compressed air is fed to the two pyramid-shaped sound horns through the piping at right. An assistant (at far right) watches through the chamber's observation panel.

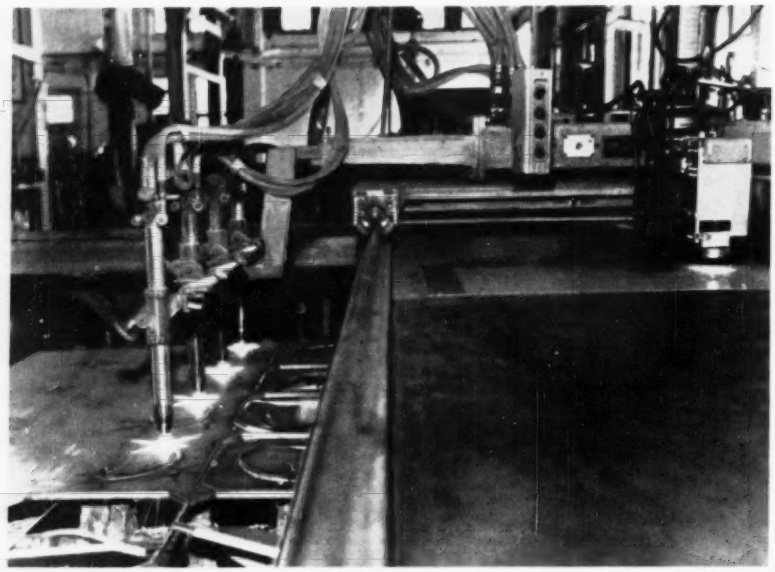
RCA believes its machine produces the world's loudest controlled noise — complex sound such as speech and music. Boeing Airplane Company (as reported in the April 1958 issue of COMPRESSED AIR MAGAZINE) has built an air-powered sound horn that produces 190 decibels, but this is sine wave sound, a simpler form. The Boeing machine is used for vibration tests of aircraft structural material.

The RCA horn may be put to work as a conventional loudspeaker as well as a noise maker, and is expected to be useful for civil defense work, and at such noisy places as jet airfields, flight decks of jet-aircraft carriers and industrial plants. It is believed the speaker can project the human voice 10 miles or more.

TWO WAYS TO CAGE A TIRE

The use of safety cages for inflating tires is a precaution taken today by a great many maintenance shops and departments. Their use prevents injury to the man wielding the inflation hose in case of a blow out. At Colorado Fuel & Iron Company's Pueblo (Colo.) Plant Garage, a mechanic's helper was faced with the task of inflating a 1400x20 tire to 90-psig pressure. Unable to fit the big wheel into the cage in the normal manner, shown at the left, the employee just crawled into the cage himself (right) and left the tire outside. Use of the cage is mandatory at the plant, and, since it was installed about 8 years ago, no one has been injured by a tire blow out.

Pen Or Pencil Drawings Guide Flame Cutter



FOUR-FLAME TORCH IN OPERATION

Under directions from the Photocell Tracer at the right, the four torches at the left cut identical sections from the metal sheet.

AN ELECTRONIC tracer, introduced by Linde Company, Division of Union Carbide Corporation, uses easily prepared pencil or ink line drawings to control single or multi-torch flame-cutting machines. The tracer has two features that make it more convenient to use than mechanical types. One is a photoelectric scanning head that permits the tracer to follow an ordinary pencil or ink line. The second is an automatic kerf compensator that makes allowance for the kerf or width taken out by the cutter.

The scanner follows the simple line and doesn't require metal or plastic templates, photographic negatives, complicated silhouettes or any such special guides. The photo cell is not sensitive to extraneous light or shadows that may fall on drawings. Because of its ability to follow closely spaced lines, which mechanical types cannot do, intricate metal shapes and small holes can be cut with the unit. At an average cutting speed, the tracer can negotiate 90-degree turns with a $\frac{1}{16}$-inch radius, and travels at a rate of 2 to 30 inches per minute.

Further, with the tracer, it is possible to follow lines that will make the cutting torches move without interruption from one series of shapes to another for "chain" cutting. When there is no further need for the drawings, they can be filed much more compactly than rigid templates made of plastic, hardwood or plywood.

The advantage of the kerf compensator is that it makes possible the use of a drawing that is exactly the shape of the part wanted. Parts can be reproduced without making allowances on the drawing for kerf width. Before operation, the compensator dial is set for the thickness of the plate being cut, and the device automatically compensates for the kerf width of that plate.

PHOTOCELL TRACER

This is the photoelectric-cell tracer component that follows simple pencil or ink drawings, directing torches that cut out metal parts. The dial at the top right regulates the speed (2 to 30 inches per minute), and the other dial is set to automatically compensate for the kerf width of the sheet. At the lower left, slightly above the paper, is the cell following the guide lines.

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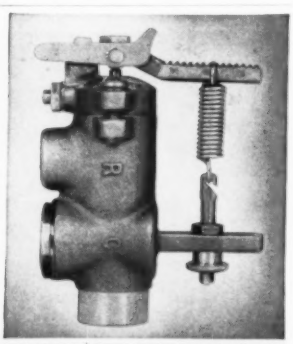

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SAVING WITH AIR POWER

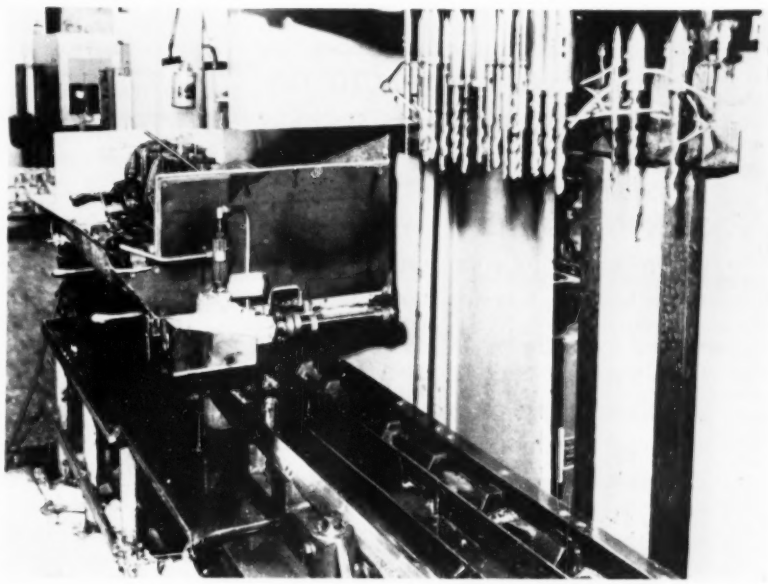
Application: Jig-Table Transfer

ALTHOUGH manufacturers and builders usually adapt air-powered tools to their needs to save on labor costs or to improve quality, situations often develop in which pure easing of work is the main objective. One such case occurred in a plant of a well-known business machine company. At the concern's assembly plant in New York State, aluminum castings are drilled, spot-faced and tapped. These operations are completed on four sides of the castings by a 7-station drilling machine that has 130 spindles. The castings are mounted in one of two jigs on 400-pound tables. The heavy tables are rolled from station to station, and the castings are rotated on the tables as required for each operation.

Because of the weight of the tables, great effort was needed to start them rolling from one station to the next. Two men did this heavy labor. They were able to work only 4 hours before they had to exchange jobs with two other men doing lighter work. The company wanted to eliminate this heavy exertion.

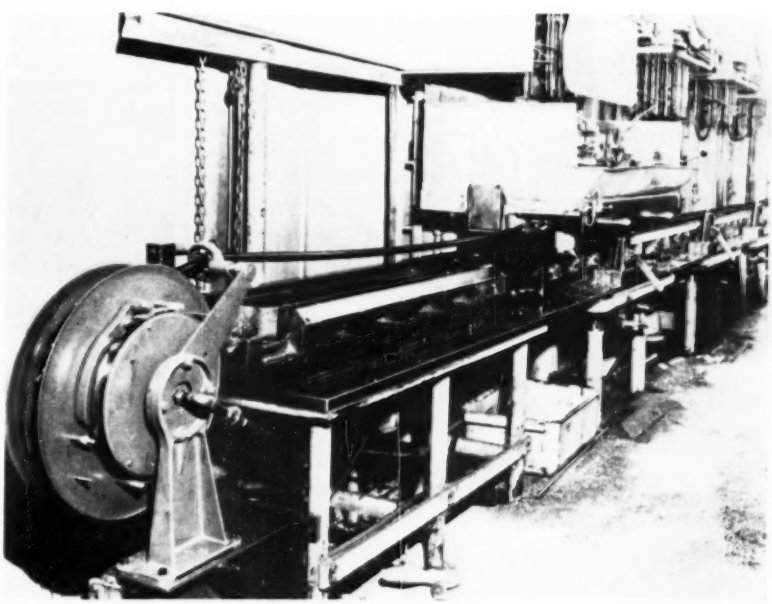
This was done by installing Ingersoll-Rand Size 22P air motors on each table. Chain drives were attached to the two axles to propel the table wheels. A hose reel was mounted at each end of the drilling machine, positioned in the center of the table to support the air hose. Air cylinders, mounted on each table, move the jig to the front or back of the table when required by the operation. Exhaust noise is effectively silenced by mufflers fitted to each I-R air motor.

Since the fitting of the air equipment, operators no longer object to working a full day on the drilling machine. The main purpose of installing the air motors was to make the work easier, and this was achieved. But another advantage has resulted also: the air-powered equipment can increase production by 10 percent if necessary.



AIR MOTOR INSTALLATION

An Ingersoll-Rand Size 22P air motor is visible here mounted on one end of a table that transports aluminum castings from one drilling station to the next. Another air motor drives an axle on the other side of the table. Use of the air motors eases work for operators who formerly pushed the 400-pound tables.



SEVEN-STATION DRILLING

The reel at left tends hose for air motors that propel the table at center. The table is moving an aluminum casting along the drill machine's stations that have a total of 130 spindles. Addition of the air motors, and other air equipment, raised production potential by 10 percent while making the work much easier.

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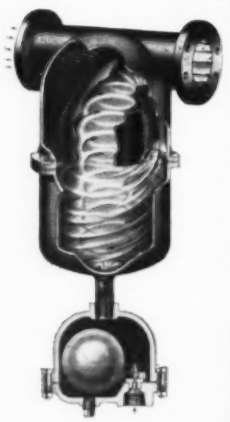

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WRIGHT-AUSTIN COMPANY

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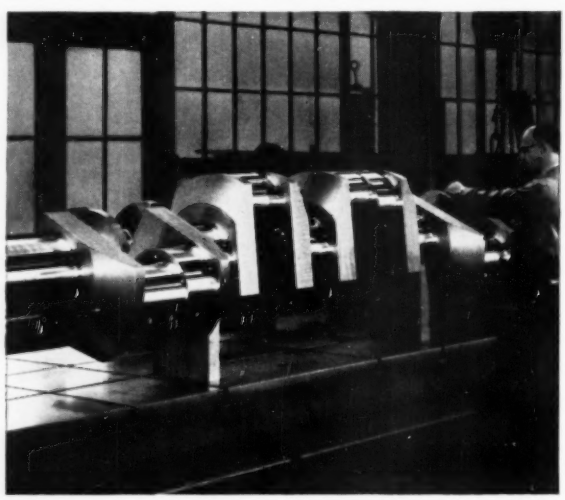


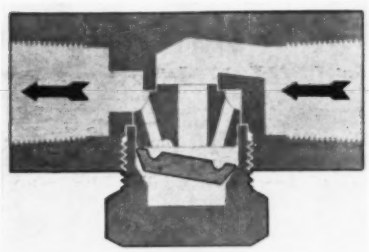
WHO FORGES THE TOUGH CRANKSHAFTS ? .... and machines them, too

NATIONAL FORGE & ORDNANCE COMPANY

IRVINE, WARREN COUNTY, PA.

Industrial Notes

IMPULSE steam traps that have been designated as Yarway No. 30 are said to permit exceptional economy of operation and maintenance in light-load applications such as on steam tracer lines, steam main drips and small platens. They are available in ½-inch size only, for operating pressures from 8 to 600 psig. Each unit is a lever-type valve that pivots about a fulcrum and discharges air and condensate at full ca-



pacity at start-up time. When the steam reaches the trap, the unit snaps shut, thus providing a close shut-off. Because of the lever action, a quiet operation is obtained. The traps feature replaceable valve-seat assemblies, have only one moving part and are of stainless steel construction. Additional information is given in Bulletin T 1744 (58), obtainable from the manufacturer. *Yarnall-Waring Company*, Chestnut Hill, Philadelphia 18, Pa.

METALLURGICAL gas processes using oxygen, nitrogen, and the injection of calcium bicarbonate and other solid materials, are described in six information reports published by the National Cylinder Gas Division of Chemetron Corporation. The publications are available to iron and steel manufacturers, foundrymen and others in the metals and chemical industries.

Information Report No. 13, *The NCG Controlled Cupola Chemistry Process*, describes a new method of using oxygen as a production tool in the cupola melting of iron. Reportedly it offers improved metal temperature control.

The use of oxygen in the malleable air furnace for refining electric furnace steel and other metals is described in Information Report No. 14. It tells two ways to improve efficiency with oxygen.

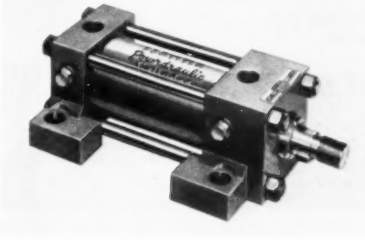
Use of oxygen to increase efficiency in the Tropenas converter is described in Information Report No. 15. It tells how using oxygen to enrich the converter air blast results in savings in silicon additions, reduced blowing time and improved metal quality.

Oxygen's applications in electric-furnace steelmaking are described in Information Report No. 16. Economic and metallurgical advantages are discussed; techniques and equipment are illustrated.

Information Report No. 17 reports on the use of the NCG solid materials dispensing unit in the treatment of molten metals, and explains advantages of using an inert carrier gas for injecting solid materials.

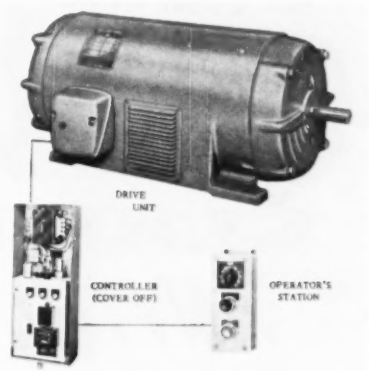
Use of nitrogen for flushing molten metals is described in Information Report No. 19. It tells how a foundry can try an inexpensive method of producing porosity-free castings by removing hydrogen that causes pinholes. *National Cylinder Gas Division*, Chemetron Corporation, 840 N. Michigan Avenue, Chicago 11, Ill.

POWRDRAULIC is the name of a line of hydraulic cylinders that feature a pressure-tightening tube seal. An O-ring located on the outside diameter of the tube is fully confined between the tube and cylinder head. Because the seal is on the tube OD, minute expansion of the tube under pressure squeezes the O-ring, increasing the tightness. Unlike those that seal at the ends or inside diameter, this seal is said to remain tight at all pressures. Powrdraulic cylinders are rated at 2000 to 3000 psig nonshock, and bore sizes range from 1½ through 8 inches. Thirteen



basic models and a choice of rod sizes permit the selection of a standard cylinder for many applications. The cylinders have industry standard mounting dimensions and conform to JIC recommendations. They have 1-piece solid steel heads with welded mountings for strength. Welding of the mountings is also said to provide accurate alignment and squareness. The cylinders have double-seal piston rings and a fast change cartridge gland which has an automatically lubricated bearing. The cast iron piston rings are bidirectional and reportedly have the sealing power of six conventional rings. Optional pistons with "U" packings of synthetic rubber are available as well as optional glands that have multiple lip seals. The company's catalog 900 describes the cylinders. *Hanna Engineering Works*, 1765 Elston Avenue, Chicago 22, Ill.

ADJUSTO-SPEDE adjustable speed drives are available in ratings from ¾- to 7½-hp with stationary field construction. All brushes, commutators and slip-rings have been eliminated, thereby reducing maintenance needed for the units. The redesigned construction in these ratings reportedly reduces the length of the drive up to 22 percent. Both the al-



ternating current motor and eddy current clutch are built into a common housing. The drive shaft, height and diameter dimensions are the same as a standard motor of comparative rating. Motor-end brackets are interchangeable with standard flanges, and units can be flange-mounted to the driven machine to save space. In the Adjusto-Spede and alternating current drives, a clutch drum turns at constant speed while speed on the clutch output member is adjusted by varying the direct current excitation to the clutch coil. Direct current is supplied by a small controller. Fingertip control of operations is provided in a separate operator's station. The drive is designed to supply precise operating speeds for machine tools, process machinery, test equipment, windups, con-

for a few cents,
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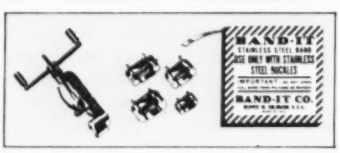
BAND-IT® CLAMPS *ANYTHING!*

EASIER • QUICKER • LONGER • STRONGER

Clamps of all diameters formed without waste, using only continuous roll of BAND-IT band, BAND-IT tool and BAND-IT buckles.

Band and buckles in 4 widths and 4 metals; 201 stainless steel, 316 stainless steel, hi-carbon coated steel and silicon bronze.



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Factory shipments of all four metals made to distributors in any quantity within 24 hours of receipt of order.

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Over 1500 Authorized Distributors in all principal cities of the United States and in 59 other countries.

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BAND-IT CLAMPS GO AROUND THE WORLD

Here is the pair for clean, dry air . .

JOHNSON AFTERCOOLER

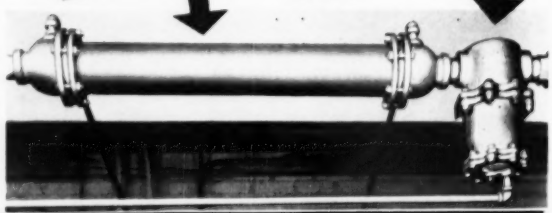
Used where moisture is vaporized by the heat of compression. Circulates cooling water around the line, condenses the oil and water vapor so Separator can remove them. Simple in design, highly efficient in performance.

SIZES FOR ALL NEEDS

JOHNSON SEPARATOR

Removes more than 99% of all water, dirt and oil from compressed air or steam. Combines the *two* best principles of separation—first allows air to expand slightly, then changes flow direction with the "Thousand Baffles". Model illustrated is the newest idea in separator design, with self-draining trap mechanism built right in.

WRITE FOR BULLETIN



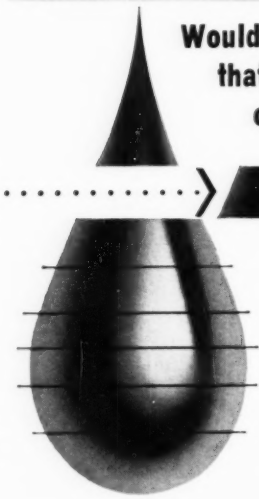
The Johnson Corporation

830 Wood Street • Three Rivers, Mich.

ENGINEERING

NEWS YOU CAN USE ABOUT ENGINE AND COMPRESSOR PERFORMANCE

Would you believe that one drop of oil could be this important?



Take a 12 cylinder, 2,000 HP, 330 RPM engine . . . let just ONE-EIGHTH OF A DROP of additional oil per stroke be used in each cylinder and here's what will happen: your oil consumption rate will increase from 8000 BHP hours per gallon to 2000! And that's the big reason Cook rings save you money—*they prevent excessive use of oil.* Specify Cook *engineered* conformable oil wiper rings, the most copied oil control rings in the world! C. Lee Cook Company, 952 S. Eighth Street, Louisville, Kentucky.

Rings and Packings Since 1888

C. LEE COOK COMPANY

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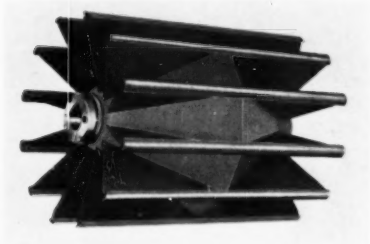
veyors and the like. It is suitable for continuous operation at full load in ranges as high as 34 to 1 and for intermittent use from zero to full speed, or any revolution speed between these. The drive has a tachometer feed-back circuit that continually monitors the drive shaft and automatically corrects speed as required. "Jogging" control is standard. Optional control features include: threading, controlled-rate starting, multipoint control, or tachometer follower control in which the driver matches a speed established at another point in the process. The Adjusto-Spede can be operated by automatic controls, such as temperature, pressure and level detecting devices. Bulletin 2750 describes the drives. *The Louis Allis Company*, Department P, Milwaukee 1, Wis.

WING-TYPE pulleys, consisting of many round-headed spokes radiating from a cylindrical hub, have been developed to minimize belt wear. The design is said to multiply belt service life because less pulley area is in contact with the line which it is driving.



Metal plates between the spokes slant from the midpoint to the hub tips to carry away material that may spill onto the belt, causing abrasive wear or corrosive weakening. The pulleys are manufactured in sizes to meet a wide range of industrial applications. They are said to have strong, welded construction for heavy-duty service and to provide a strong grip. Typical installations include elevator boot pulleys and conveyor tail pulleys. *R. & J. Dick Company, Inc.*, Box 338, Passaic, N. J.

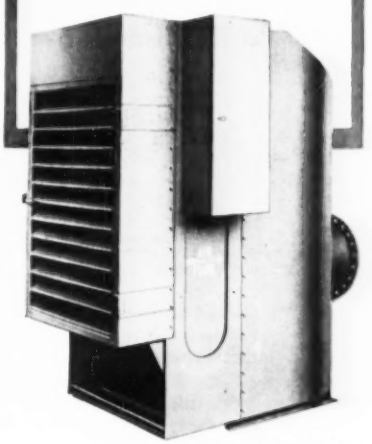
AIR-POWERED jacks are used for spot system maintenance of railroad cars. The units reportedly cost half as much as below-surface types and require no expensive installation. The 35-ton-capacity units (Model 35 AHL) are applied in pairs on the rip track. They may be moved inboard and outboard instantly by air cylinders so that a finished car may be removed and the next car quickly put into place. If several separate lifting operations in different areas are required, the air-cylinder cost may be avoided by specifying the jacks as standard units. Solid aluminum alloy construction, low center of gravity and semipneumatic tires ease positioning. The jack's lifting toe is at the same

height as the car's jacking point, thereby eliminating wasted travel time and distance needed by surface or subsurface lifting devices. Power to raise the jacks is supplied by compressed air driving safe and efficient Ingersoll-Rand air motors. A multiple valve arrangement permits synchronization for level lifting. All hose, coupling and valves required for this simultaneous operation are included with two or more jacks. Height of jack rise is 52½ inches from a starting point of 24 inches. Over-all height is 101 inches and the base width is 31 3/16 inches. Weight is 1620 pounds. A foolproof shutoff mechanism automatically stops the jack at the top and bottom of rise, and the jacks automatically lock under the load in case of air failure. *The Joyce-Cridland Company*, 2027 E. First Street, Dayton 3, Ohio.

SELECTION and installation of vee belts are described in a 12-page illustrated manual, *How to Get Longer Life from V-Belt Drives*. The publication (Catalog No. IP-1577), available without charge, tells how to detect belt trouble, diagnose failures and correct drive troubles. A list of valuable suggestions for proper V-belt maintenance is included as well as an inventory survey check list for this type of drive. *B. F. Goodrich Industrial Products Company*, Akron, Ohio.

SOUNDS emitted by air-operated devices can be muffled with silencers made of long-lasting Polyether foam enclosed in anodized aluminum. Efficiency of employees is said to be increased by these units, built in three models. Model M-1, mounted flush to a ⅛- or ¼-inch exhaust port, protrudes only ¾-inch.

AAF
Multi-Duty
Filters
Assure
Clean Intake
Air
Automatically



Type CMS Multi-Duty for air volumes of 3000 CFM and up.

When your engines and compressors are protected by AAF Multi-Duty Self-Cleaning Filters, you *know* that intake air is *clean.*

Uniform air delivery, constant efficiency, low operating resistance and infrequent maintenance are "musts" for true dust protection. Multi-Duty measures up on every count because this filter keeps itself "fit" through continuous self-cleaning action.

Would you like more information? Write today for our 16 page illustrated catalog.

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American Air Filter
COMPANY, INC.
402 Central Avenue, Louisville 8, Kentucky
American Air Filter of Canada, Ltd., Montreal, P. Q.

Model M-2 is only 1 inch long and will also accommodate ⅛- and ¼-inch exhaust ports. The largest size is designated as M-3. It is 1¾ inches long and fits a ⅜-inch port. These inexpensive devices, said to be rustproof throughout, can be cleaned with most common solvents. *Mead Specialties Company*. 4114 N. Knox Avenue, Chicago, Ill.

AIR and hydraulic hose, that is resistant to oils, greases, and lubricants, is described in a 4-page flier. The hose may be coupled with various reusable fittings as well as barb fittings and clamps, and is said to have superior abrasion resistance. Described also are flexible plastic tubings designed for a variety of uses: for laboratory work where extreme clarity is desired; for nontoxic uses such as handling beverages and foods; and for transporting gasoline and similar hydrocarbons. Sizes available and physical properties are listed. Mentioned too are special shrink tubings—solution-dilated lines that air-dry shrink; and plastic coatings that are utilized for protection of equipment and for covering air-dry racks. *Munray Products*, 12400 Crossburn Avenue, Cleveland 25, Ohio.

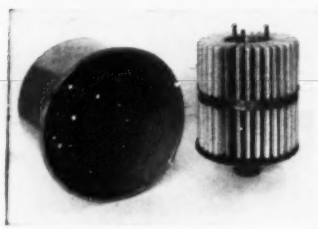
VERTICAL gearmotors are available with either flanged mounting faces, or with standard vertical extended housings. The motors are supplied in double or triple reduction types with lifetime gearing, in ratings from 1 to 75 hp, and reductions from 350 to 7½ rpm. Built with standard motors in drip-proof, totally enclosed fan-cooled, or explosion-proof enclosures, the units operate at normal torque, on 3- or 2-phase, 60-cycle currents of 208, 220/440 or 550 v.

Special voltages and frequencies as well as mechanical modifications are also available. *The Lima Electric Motor Company, Inc.*, subsidiary of Consolidated Diesel Electric Corporation, Department 133, Lima, Ohio.

BALL BEARING trolleys and how they work in maintaining the efficiency of trolley conveyors are described in detail in Book 2636. It contains twenty pages of specific data about the types and sizes available, the selection of new units and attachments, and the replacement of units in existing installations. (Trolleys are available in two series for operation on 3-, 4- and 6-inch I-beam tracks.) It also includes application and maintenance information along with data about trolley wheels, rollers for roller turns and special types of trolleys

NEW DRY TYPE AIR FILTERS

for engines, compressors, blowers and other industrial applications



• Designed for specific applications, the new Air-Maze Dry Type filter is particularly suitable where 1.) oil free air is required, 2.) an extremely high degree of filtration is required, 3.) the air velocity varies from one period to another and, 4.) the dirt concentration is relatively low, except when vibration is present to help dirt removal.

The Air-Maze Dry Filter is one of the most efficient mechanical type filters available. Laboratory tests indicate better than 98% efficiency with particles of 2 micron mean diameter and practically 100% efficiency with particles of 5 microns or larger.

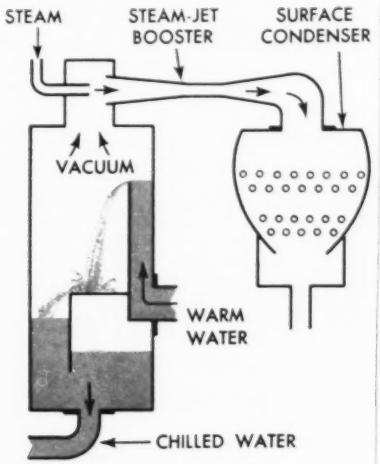
The Air-Maze Dry Filter type DA employs a special highgrade felt filtering media arranged in deep pleats to provide extended area, and armored on both sides by heavy galvanized cloth. Heavy gauge perforated tubing inside the media and a metal strap on the outside form a rigid unit of great strength and are corrosion protected. Made in sizes from 20 cfm to 6650 cfm. Catalog DA-1056 available. Write **AIR-MAZE CORPORATION**, Cleveland 28, Ohio. Department CA-2

AIR-MAZE

The Filter Engineers

AIR FILTERS • SILENCERS • SPARK ARRESTERS • LIQUID FILTERS
OIL SEPARATORS • GREASE FILTERS

How to
REFRIGERATE
with
WATER



In I-R Steam-Jet Coolers, water is the only refrigerating medium used!

Water and steam are *all you need* to provide a dependable supply of chilled water, at temperatures down to 35 F, when you use an Ingersoll-Rand Steam-Jet Refrigerating System.

There are no hazardous gases, no high pressure vessels or equipment, and no vibration. Water is chilled by *evaporation* in a vacuum chamber which is evacuated by a steam-jet ejector. Either barometric or surface condensers can be used, depending on the economics of the installation.

Advantages of this I-R system include safety, ease of installation, uninterrupted service, large overload capacity, low maintenance and ease of control. Combinations are available for any capacity between 30 and 1500 tons of refrigeration.

Send for Bulletin No. 9143-B

Ingersoll-Rand
4-777 ♥ 11 Broadway, New York 4, N. Y.

that are available for electrified and heavy-duty foundry applications. *Link-Belt Company*, Prudential Plaza, Chicago 1, Ill.

SANDBLASTING machine operators may find useful a sandblaster's helmet that is made of mediumweight canvas. The helmet is supported by a comfortably fitting fiber frame, and its headpiece assembly is adjustable to all normal head sizes. As seen in the photograph above, the protector is fitted with clear, laminated safety glass, 3x5 inches in size, that reportedly can be replaced with little trouble. The glass is protected by a fine mesh wire screen. Wire screen is also located on both sides of the safety garmet to provide ventilation for the wearer. *Industrial Products Company*, Philadelphia 33, Pa.

HYDRAULIC presses, both air- and manually-operated, are described in an 8-page bulletin, DH-126. Thirteen units with various ratings and capacities—from 3 to 150 tons—are listed and illustrated. The presses are said to be high in quality and safe, while also lightweight, compact and versatile. Capabilities, capacities, dimensions and weights are presented in concise tables in the 2-color flier. *American Chain & Cable Company*, ACCO Equipment Division, York, Pa.

TORQUES from 5 to 250 ounce-inches are measured by a torque meter that takes readings on shafts turning between 50 and 12,500 rpm. Scales on the face of the instrument are said to be easily read, and simple calibration minimizes operator error. Dynamic torque figures indicated by the device are reportedly accurate within 2 percent and are independent of shaft speed and direction of rotation. Remote readings may be taken by use of a convenient electrical torque

ADAMS FACT FILE #2

PLANT AIR

Moisture Chief Cause of Trouble . . .

Every company today is looking for ways to offset the increased costs of labor, material, equipment and services. At a gasoline station you expect "Free Air", but in industry it is a major expense. Perhaps in your own plant, for an investment in a few minor compressed air system alterations, significant savings are possible.

Water, sludge, rust, oil and dirt in compressed air systems are prime causes of maintenance and production down-time. Water vapor condensing in air lines tends to corrode the piping. Also, water present in the piping may freeze during winter, causing serious reduction of compressed air supply. Such restrictions are often difficult to locate and thaw. This same line moisture may emulsify lube oil destroying its lubricating value and the resultant mixture has high fouling characteristics. Frequently, ice will form within the tool itself since expanding air cools the moisture . . . tool efficiency will be seriously affected.

Some of the Other Problems Created By Wet Compressed Air . . .

Wet compressed air is not only a construction and production tool problem. Faulty paint jobs, contaminated chemical and food products can often be traced to moisture laden compressed air. Waterhammer, unequal pipeline thermal expansion and line leaks also result from collected moisture. In addition, air lost through traps, and in blow-down of compressed air lines provide no useful work . . . represent a sizeable power loss.

You Can Lick Compressed Air Moisture Problem . . .

All of these hidden costs can be virtually eliminated by the installation of an Adams Aftercooler and Cyclone Separator between the compressor and receiver tank. By cooling discharge air to within 10° F. of cooling water temperature — guaranteed with Adams standard Aftercoolers — the moisture can be removed at the separator. Pressure loss is less than one-half pound on these units including the separator. In severe cases, moisture removal of over 90 per cent can be obtained by cooling the air with Adams 2° Aftercooler to within 2° F. of water temperature.

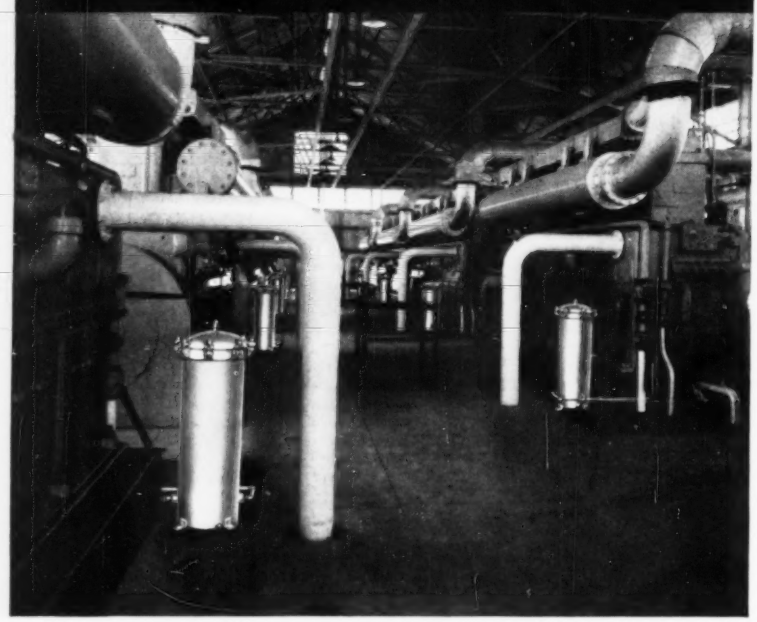
Air Filter for Final Protection at Point of Use . . .

As an added safeguard for expensive tools and equipment, an Adams Poro-Stone Air Filter should be installed just before the air is used. These filters remove all solid material picked up by the air stream. With an Adams Aftercooler, Cyclone Separator and Air Filters clean, dry, trouble-free air is supplied to your production tools. You get continuous service with minimum maintenance.

For further information on how the complete line of Adams air equipment can solve your compressed air problems, write today for your free copy of Bulletin No. 712 on Aftercoolers and Bulletin No. 117 on Poro-Stone Air Filters from the R. P. Adams Company, Inc., 209 East Park Drive, Buffalo 17, New York.

NUGENT FILTERS

Keep Lube Oil Clean for El Paso Natural Gas Company



Twenty-seven gas engine compressor units, each equipped with a Nugent Lube Oil Filter, have been in service at the Goldsmith plant of El Paso Natural Gas Company since 1949.

Excellent bearing, ring and cylinder wear maintenance records are positive proof that Nugent Filters have performed an outstanding job in keeping lube oil clean . . . free from sludge, acidity and harmful impurities that can accelerate wear and shorten engine life.

For safe, effective filtering protection for your valuable equipment . . . always specify Nugent Fuel and Lube Oil Filters . . . available in a wide range of types and sizes. Write for descriptive literature.

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WM. W. NUGENT & CO., INC.

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OIL FILTERS • STRAINERS • TELESCOPIC OILERS
OILING AND FILTERING SYSTEMS • OILING DEVICES
SIGHT FEED VALVES • FLOW INDICATORS

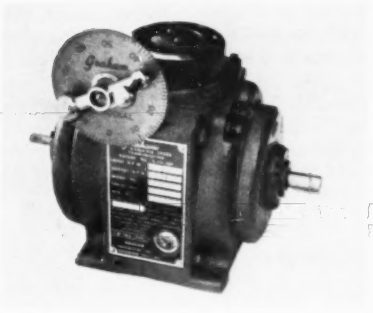
pickup that imposes negligible bearing loads. The unit is designed to provide protection up to twice its highest rating. Pickup housings are 3 5/8 to 5 inches long, depending upon the range desired, and shafts are 1/4 inch in diameter and 7/16 inch long. Laboratory, shop or field personnel will reportedly find the handy torque meter useful. *Metron Instrument Company*, 432 Lincoln Street, Denver 3, Colo.

INSTRUMENT housings of reinforced fiber glass have been introduced to provide lightweight, strong and corrosion-proof enclosures. The housings are ideal for use in the chemical and allied industries where corrosion is a particular problem. As seen in the photograph above, the housings resist such materials as acid, alkali, salt water and solvent. The units can be formed of any color, it is said, and the color is present through the entire depth of the fiber glass. *Warminster Fiber Glass Company*, Box 254, Hatboro, Pa.

MIDGET valves and fittings that offer a wide range of mechanical seals and controls are described in Catalog No. 658. The units are used to provide minimum capacity in capillary and small-diameter, high-pressure tubing systems. Discussed are four standard HIP tubing connections, 2- and 3-way midget valves, fittings and safety head assemblies. Working pressures range from 10,000 to 60,000 psig. *High Pressure Equipment Company*, 1222 Linden Avenue, Erie, Pa.

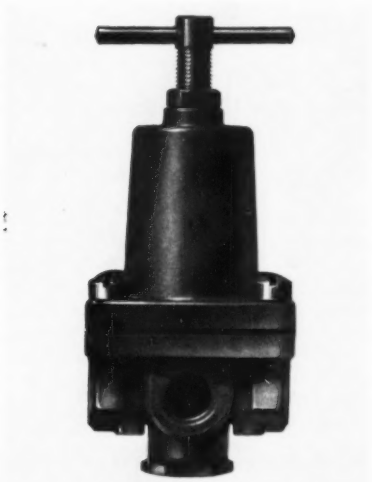
SPEED settings of one part in 4000 reportedly can be achieved with a micrometer dial that is optional equipment on variable speed drives. Anti-backlash control linkage on the "Microdial" permits similar accuracies in

holding speed and resetting. Any speed to the unit's maximum can be adjusted faster or slower, while the transmission is running or at rest. The transmission is available either with or without a built-in motor, and a variety of built-in



reductions, including single and 2-stage in-line types, and right angle worm gears with output shafts located horizontally or vertically. Self-lubricated, the transmission has overload protection that prevents damage to itself or to the driven machine in the event of jam or overload. Sizes range from ⅛ to 3 hp. Other controls are also available, including pneumatic or electrical types in which the speed is regulated in proportion to a variety of control signals. *Graham Transmissions, Inc.*, Menomonee Falls, Wis.

AN AIR-PRESSURE regulator for low-cost, general-purpose applications is extremely compact in design. It belongs to Watts' Series 112 and is expected to meet a wide range of requirements where larger, more expensive regulators were previously specified, such as in competitively priced air compressors and paint spray rigs. Constructed of die-cast zinc, with internal parts of brass, and diaphragm and disk of oil-resistant



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Everywhere!

Yellow Cover
Black Spiral Stripe

"HARDROK" Wire Braid AIR HOSE is being more and more widely used as its reputation for unequalled performance grows. You'll find it coupled to drills, jumbos and other heavy-duty air equipment on the toughest, roughest jobs. There's no mistaking its yellow cover with black spiral stripe . . . sure sign of longer service life and lower hose costs.

"Hardrok" specifications include oilproof Synplastic® tube; horizontally braided steel wire carcass; tough, wear-resistant rubber cover; ½" to 3" sizes; maximum lengths of 50 feet.

"If it's GOODALL, it MUST be Good!"

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DEPENDABLE AIR POWER

CAN IMPROVE THE

Efficiency

OF YOUR PRODUCT

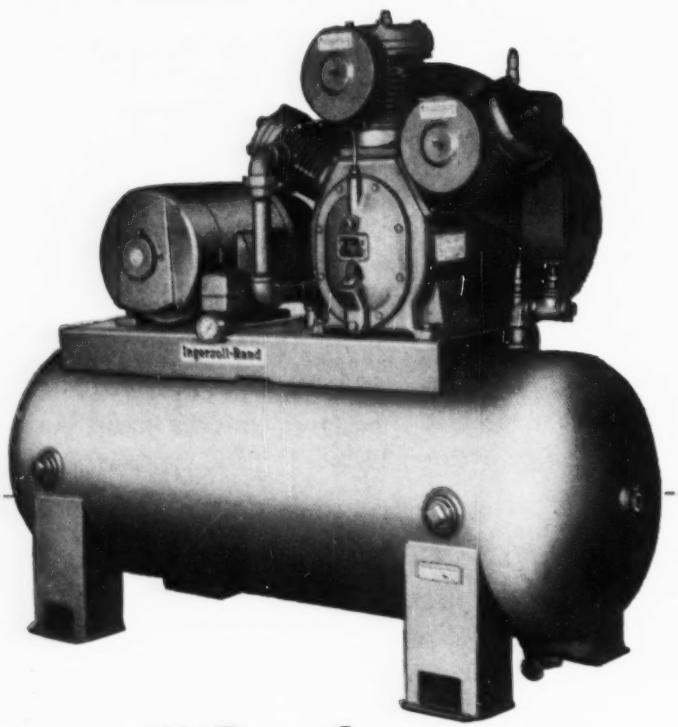
When operation of your equipment hinges on a dependable source of air, get the best compressor. It will add quality and efficiency to your product.

Year after year, since 1878, Ingersoll-Rand air compressors have set new standards of dependable operation through modern design, engineering and production facilities.

Bare, baseplate or receiver mounted air compressors can be supplied to meet your requirements.

Packaged air-cooled compressors—½ through 20 horsepower

Other compressors to 6000 horsepower



Ingersoll-Rand

11 Broadway, New York 4, N.Y.

3-596

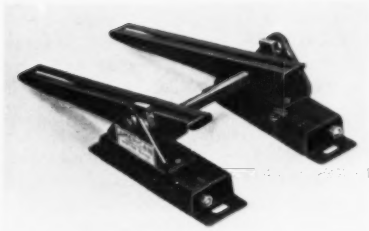
Buna-N, the valve is available in ¼-inch size only. *Watts Regulator Company*, Industrial Division, 10 Embankment Road, Lawrence, Mass.

SEAMLESS and electric resistance-welded steel tubing in mechanical, aircraft mechanical, airframe and pressure grades is described in an 8-page catalog, No. CS-59. This, the 1959 edition, contains information about fabricated and forged steel tubing, special shapes, tolerances and size ranges. *Copperweld Steel Company*, Ohio Seamless Tube Division, Shelby, Ohio.

BREATHERS of 40-micron capacity, for free flow of clean air into hydraulic fluid, fuel and oil reservoirs are described in a 2-page data sheet (No. 101). Included are photographs of the filters, air-flow pressure drop curves, operating descriptions, cross-section drawings and specification tables for the line. *Bendix Filter Division*, Bendix Aviation Corporation, 434 W. Twelve-mile Road, Madison Heights, Mich.

TENSION-CONTROL motor bases are available from The American Pulley Company. They can handle NEMA frame motors up to, and including, 100-hp. (Previously, 30 hp was the largest size that could be mounted on these automatic, belt-tensioning motor bases.) Called Econ-O-Matic, they are manufactured of all steel. They prevent belt slippage and speed-losses at peak loads, thereby increasing belt service life by almost 50 percent, it is said. In addition, maintenance time is reduced drastically by elimination of the need for adjustment. The three motor bases are

"Look at that—35c for a sandwich and the meat's only 0.049 inch thick!"



designated as 9K, 11K and 13K; and take NEMA motor frame sizes up to No. 405, No. 445 and No. 505, respectively. *The American Pulley Company*, Philadelphia, Pa.

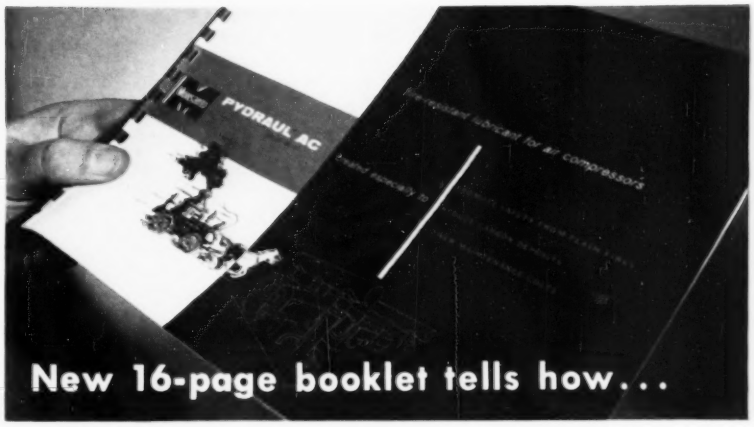
DIESEL-ENGINE controls are detailed in a 24-page bulletin (No. B45-1). It is directed exclusively to the diesel field, and describes temperature and pressure control systems, safety devices, tachometers, control motors, valves, relays and related accessories. *Minneapolis-Honeywell Regulator Company*, Industrial Division, Wayne and Windrim avenues, Philadelphia 44, Pa.

Training . . .

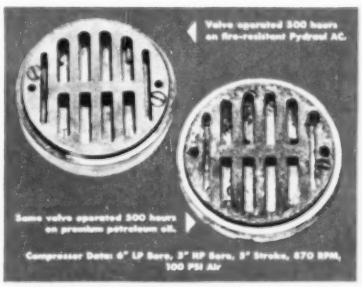
Installation, Operation and Maintenance of Fluid Power Equipment (Published by Hitchcock Publishing Company, Training for Industry Division, 222 E. Willow Avenue, Wheaton, Ill.) is the name of an "on-the-job" training course. It is described as a solution to help remedy the shortage of trained personnel in the current, quickly expanding, fluid power field. The authors of the program are two experts in fluid systems: Dr. R. C. Binder, who is professor of mechanical engineering at Purdue University; and Harry L. Stewart, who is in charge of special engineering for a supplier of fluid power equipment, the Logansport Machine Company, Inc., Logansport, Ind.

The course is divided into two general phases. The first requires the student to study eighteen chapters of text material about fluid power. Each chapter is sent to the student individually. After each has been studied carefully, the student answers a set of questions that accompanies it. He returns the answers and a trained instructor grades them, making any remarks he believes appropriate. The instructor will also answer questions from the student. Then, the grades are sent to the student with the next chapter to be studied. This procedure continues at the student's own pace until all eighteen chapters have been finished.

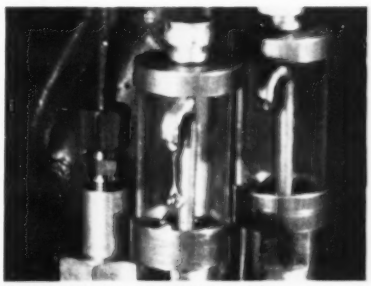
After satisfactory completion of this first portion of the course, the student is eligible to attend the course's "workshop." Two days of laboratory and practical instruction are given at the



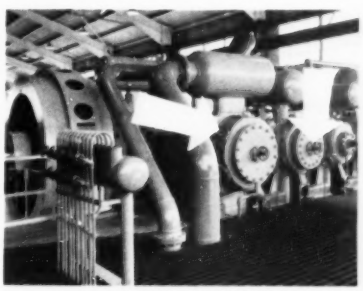
PYDRAUL AIR COMPRESSOR LUBRICANT GIVES 3 "MOST WANTED" BENEFITS AT LOWEST COST: LOW UPKEEP, PEAK LUBRICATION, FIRESAFETY


Valve operated 500 hours on fire-resistant Pydraul AC.
Same valve operated 500 hours on premium petroleum oil.
Compressor Data: 6" LP Bore, 3" HP Bore, 5" Stroke, 670 RPM, 100 PSI Air

PYDRAUL AC RUNS CLEAN—can substantially cut compressor upkeep costs because it reduces build-up of carbon and other deposits—extends time between overhauls. Side-by-side photos (above) of an exhaust valve—used in the same industrial air compressor with only the lubricant changed—show how Pydraul keeps systems freer from harmful and dangerous deposits than a premium oil. Lower maintenance costs alone usually justify use of Pydraul.



PYDRAUL AC LUBRICATES like premium-grade oil—good anti-wear and noncorrosive features give equipment long life. And Pydraul is the one lubricant for virtually every compressor you own—has demonstrated excellent lubricating efficiency in hundreds of compressors of all sizes produced by all major manufacturers—gives trouble-free compressor operation for many years. Now, Pydraul is effectively lubricating compressors operating at over 4500 psi.—many operating continually with exhaust air temperatures of 340°F.



FIRESAFE PYDRAUL AC GIVES protection 2 ways in this danger zone—guards these three 4,000-hp. compressors. Petroleum oil residues deposit inside cylinders, valves, piping—glow hot and flake off—can unpredictably ignite flammable vapors from hot petroleum-based lubricants, causing fire . . . explosion! Monsanto's synthetic lubricant, Pydraul AC, essentially eliminates this basic cause of most compressor fires and explosions: It lessens carbon deposits and oxidation residues, and it is *fire-resistant*.

PHOTO COURTESY GRACE CHEMICAL CO. PYDRAUL—MONSANTO T. M. CITY OF W. R. GRACE & CO. REG. U. S. PAT. OFF.

New, illustrated booklet gives more details, including how to make the easy conversion to Pydraul AC. Write, today. No salesman will call unless you so request.

Monsanto

FOR CONVENIENCE, USE QUICK REPLY COUPON

Monsanto Chemical Company
Organic Chemicals Division
Dept. CA-4, St. Louis 66, Mo.

Please send me the new 16-page booklet on fire-resistant Pydraul AC lubricant for air compressors.

Name _____

Company _____

Address _____

City _____

FOR LOWER TON-MILE COSTS

Replace with *DEPENDABLE* CONTINENTAL RED SEAL POWER

In highway hauling, as elsewhere, profit margins continue to shrink, and wise choice of rolling stock becomes more essential than ever. That is why more and more truckers are replacing original equipment engines with rugged Continentals, engineered expressly for the job. Choose from the models listed below. See your distributor today.

RED SEAL TRANSPORTATION ENGINES

GASOLINE

Model	Cyl.	Displ.	Bare Engine H.P.
N4062	4	62	26.3 @ 3500 RPM
Y4069	4	69	28.0 @ 3400 RPM
Y4091	4	91	36.0 @ 3400 RPM
F4124	4	124	47.0 @ 3200 RPM
F4140	4	140	52.0 @ 3200 RPM
F4162	4	162	58.0 @ 3200 RPM
F6186	6	186	77.0 @ 3500 RPM
F6209	6	209	90.0 @ 3500 RPM
F6226	6	226	98.8 @ 3500 RPM
F6244	6	244	103.3 @ 3500 RPM
M6271	6	271	96.5 @ 3000 RPM
M6290	6	290	108.0 @ 3000 RPM
M6330	6	330	125.0 @ 3000 RPM
M6363	6	363	146.0 @ 3000 RPM
B6371	6	371	123.5 @ 3000 RPM
B6427	6	427	142.0 @ 3000 RPM
F06226	6	226	126.2 @ 3400 RPM
K6271	6	271	114.5 @ 3200 RPM
K6290	6	290	123.0 @ 3200 RPM
K6330	6	330	147.0 @ 3200 RPM
K6363	6	363	162.0 @ 3200 RPM
T6371	6	371	143.8 @ 3000 RPM
T6427	6	427	170.0 @ 3000 RPM
U6501	6	501	186.0 @ 2600 RPM
R6513	6	513	192.2 @ 2800 RPM
R6572	6	572	220.0 @ 2800 RPM
R6602	6	602	232.0 @ 2800 RPM
S6749	6	749	250.0 @ 2800 RPM
S6820	6	820	300.0 @ 2800 RPM
V8603	8	603	260.0 @ 3200 RPM

CUSHIONED POWER DIESEL

Model	Cyl.	Displ.	Bare Engine H.P.
TD6427	6	427	146.5 @ 2600 RPM
RD6572	6	572	172.0 @ 2400 RPM
VD8603	8	603	200.0 @ 2800 RPM
SD6802	6	802	225.0 @ 2200 RPM

PARTS AND SERVICE EVERYWHERE

CONTINENTAL MOTORS ® Powerful as the Nation AMERICA'S STANDARD

Continental Motors Corporation

MUSKEGON • MICHIGAN

6 EAST 45TH ST., NEW YORK 17, NEW YORK • 3817 S. SANTA FE AVE., LOS ANGELES 58, CALIF.
6218 CEDAR SPRINGS ROAD, DALLAS 9, TEXAS • 1252 OAKLEIGH DR., EAST POINT (ATLANTA) GA.

course headquarters by experts in fluid power. The workshop fees, including instruction, lodging, meals and transportation to and from class, are included in the tuition for the course. Transportation to the workshop location, however, is not. A certificate of proficiency is given upon completion of the entire course.

The eighteen chapters that make up the correspondence portion of the program start with basic physical concepts needed for learning about pneumatic and hydraulic systems, and work through explanations of the components of fluid circuits and systems. The following is a sequential list of chapters: An Introduction to Basic Hydraulics and Basic Pneumatic Devices and Systems; Pressure, Work and Power; General Features of Machines and Terminology; Hydraulic and Pneumatic Symbols and How They Are Used in a Circuit; Air Compressors and Accessories; Hydraulic Power Devices; Hydraulic Fluids; Piping; Air Filters, Pressure Regulators and Lubricators; Directional Control Valves —Function and Operation; Flow Controls; Pressure Controls; Cylinders — Nonrotating and Rotating; Pneumatic Motors and Tools; Rotary Hydraulic Motors and Hydraulic Transmissions; Accumulators; Pressure Boosters; and Causes of Circuit Failures.

The course is designed for salesmen, foremen, shop mechanics and operators. Both experienced and inexperienced personnel reportedly will benefit from it. The eighteen chapters sent by mail become a reference book if kept in a green, hardbound, plastic-covered ring binder that comes with the course.

Tuition for the program without the workshop is $95 per student; this is reduced to $65 each, if there is a group of five or more company-sponsored students. Tuition for the course including the workshop is $150.

"Hey, Tex!"

Prime Contractor: Merritt-Chapman & Scott Corp.

DRILL STEEL BORES BOLT HOLES AT GLEN CANYON DAM—One of the world's highest dams, Glen Canyon, is now under construction on the Colorado River in Arizona, a mere 12 miles from Utah's southern boundary. It is being built for the U. S. Bureau of Reclamation to provide a storage basin 186 miles long, and to furnish power to a five-state area. Upon completion, the dam, 1500 ft across its crest, will rise 580 ft above the river, and join the sheer 700-ft-high canyon walls. In the photograph above, Bethlehem Hollow drill steel is boring holes in the tough sandstone face of the canyon. Bethlehem anchor bolts, in 6 ft and 8 ft lengths, were later inserted in the holes to prevent the rock from spalling.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

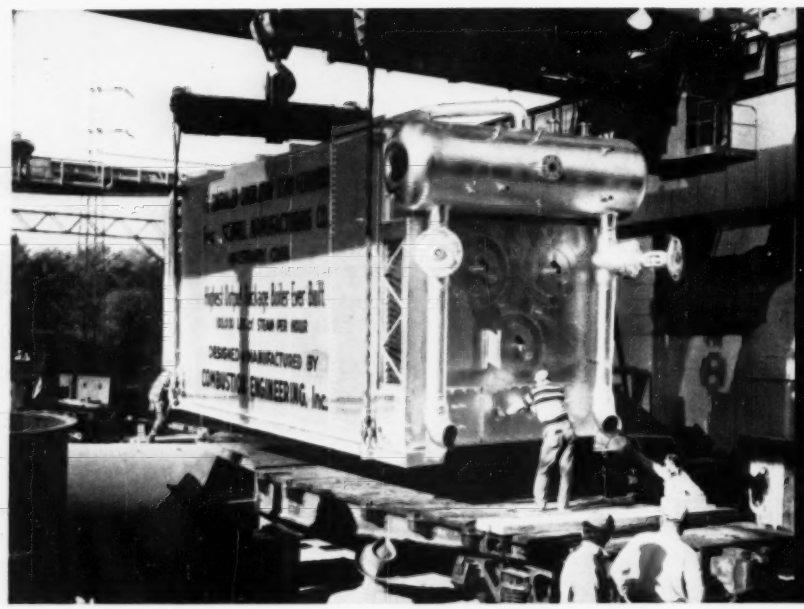
On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

Announcing

THE C-E CONTROLLED CIRCULATION PACKAGE BOILER...Type PCC



A NEW HIGH PERFORMANCE DESIGN OFFERING

•

Capacities to to 100,000 lb per hr

•

Pressures to 1,000 psi

•

Temperatures to 900 F.

Another Combustion first in the boiler field — the type PCC package unit, utilizing controlled circulation. This one, being loaded at our St. Louis shops for delivery to Scovill Manufacturing Co., is the world's highest output package boiler, having a design capacity of 100,000 lb of steam per hr. This picture illustrates the ease with which this new, high performance design can be readied for shipment. Its size permits transfer from railway siding to destination by truck.

Available for the first time to industrial steam users is C-E's famous controlled circulation design in a convenient package size. The oil- or gas-fired PCC offers capacities from 80,000 to 100,000 lb per hr, pressures from 450 to 1000 psi, and temperatures to 900 F. Higher pressures and temperatures are obtainable if desired.

Seven PCC boilers are now in service. One of these is a special-purpose design for steam conditions of 1500 psi and 1050 F.

The PCC is especially suitable where space is limited, yet high capacity, temperature, and pressure are required. It is only through the use of controlled circulation that such a compact, high-performance unit could be built. This exclusive C-E design assures positive distribution and control of water to all circuits, permitting the PCC to be placed on the line faster than any natural circulation boiler. It also allows easy handling of rapid load swings with high quality steam production.

Not only does the PCC combine outstanding performance in a unit requiring less space per pound of steam, but also it offers the inherent advantages of package boiler design: quality shop assembly by experts, quicker delivery, much less plant disruption for installation and, of course, cost advantages due to these features.

If your future steam requirements call for a high performance boiler, it will pay you to investigate the PCC. It offers utility type boiler quality in a compact package along with the economy and reliability characteristics of C-E design.

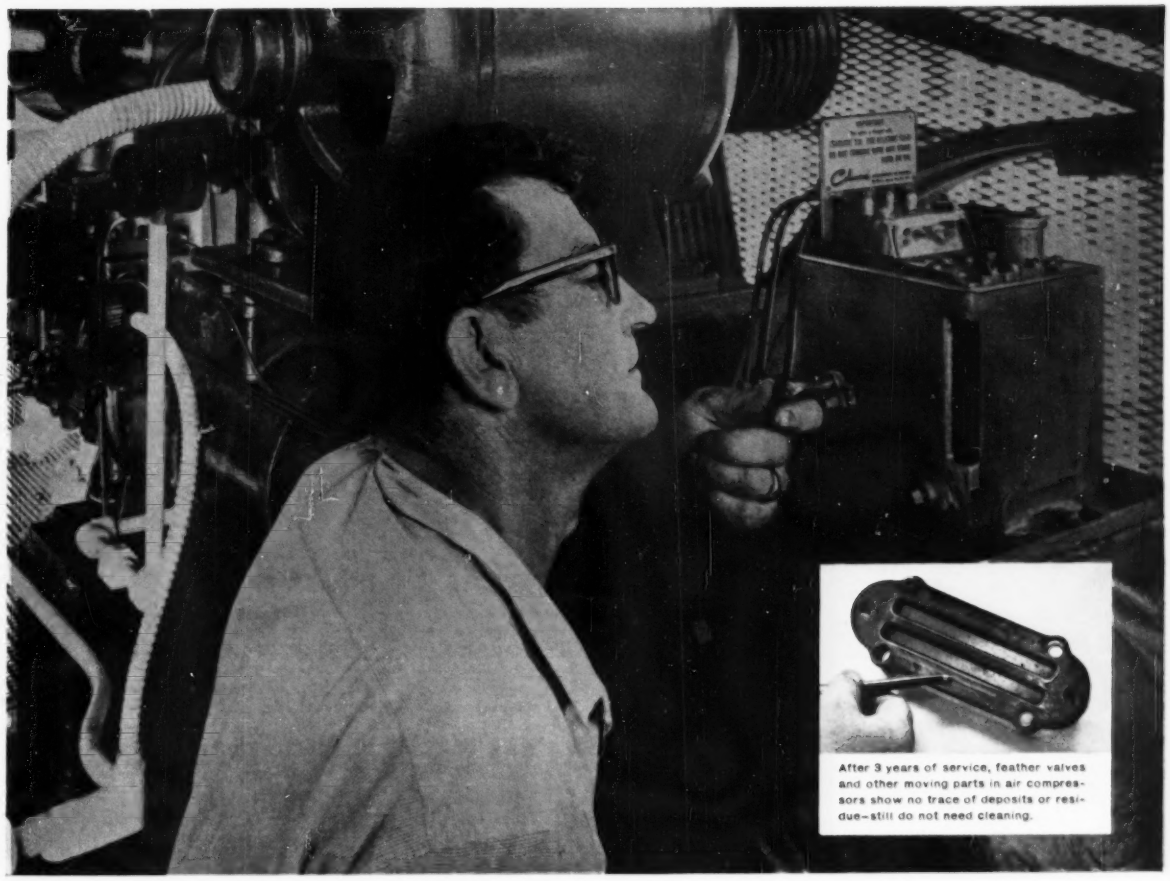
THE PCC

Meets these industrial steam needs	with these advantages
• Power generation—with or without process steam requirements.	• Controlled circulation
• High capacity, temperature, pressure.	• Quality shop fabrication
• Maximum generating capacity in limited space.	• Ease of shipment
	• Minimum plant down-time for installation
	• Earlier delivery than possible with field erection

COMBUSTION ENGINEERING

Combustion Engineering Building **200 Madison Avenue, New York 16, N. Y.** C-169A

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS; PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE



After 3 years of service, feather valves and other moving parts in air compressors show no trace of deposits or residue—still do not need cleaning.

"Cellulubes eliminate fires and explosions ... keep compressor parts clean"

says MR. T. E. DANIEL, Foreman, Cypress Compressor Station
Trunkline Gas Company, Cypress, Texas

"Since using Cellulube 220 in our air compressors we have never experienced or had any indication of fire or explosion in our compressed air systems," continues Mr. Daniel.

Installed at Trunkline's Cypress Compressor Station when it opened three years ago, Cellulubes thus provide an authoritative 7800-hour operating record that indicates not only efficient and far safer operation, but substantial savings as well. Mr. R. C. Carter, Trunkline's Compressor Department Superintendent, describes them thus:

"First and most important, of course, is the elimination of any risk to our personnel—from fire, explosion, or fragmentation. Secondly, we save on heavy equipment replacement costs, and thirdly, down-time losses.

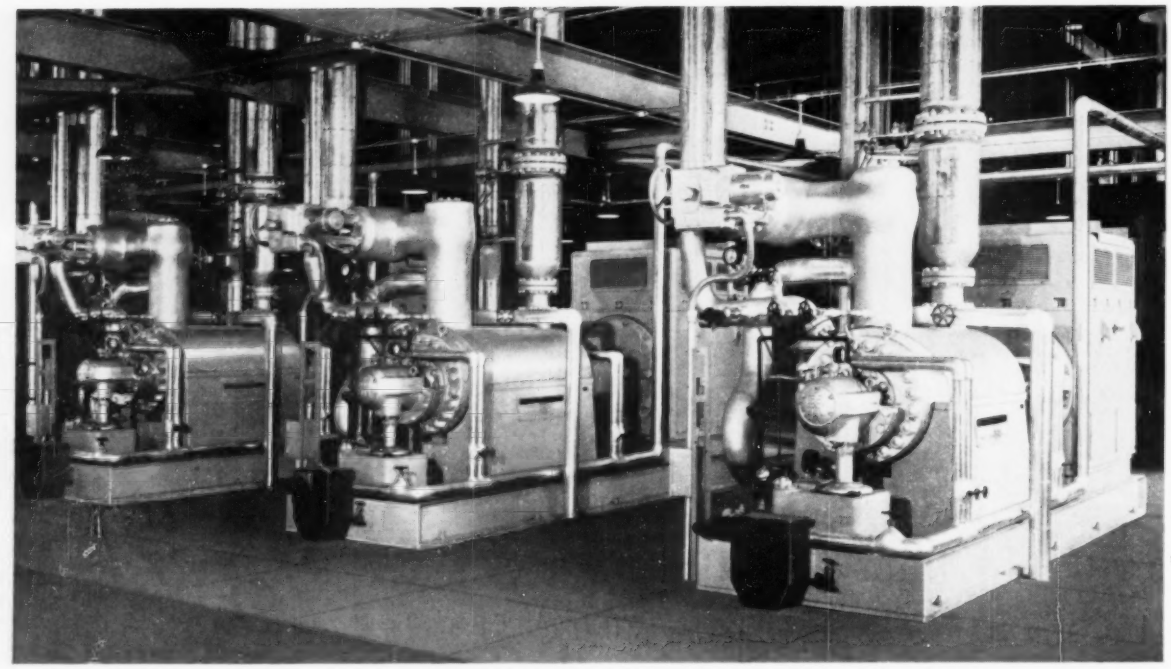
"A major savings is in preventive maintenance. Formerly, we completely disassembled and cleaned air compressors every six months. Cellulubes keep machinery so clean that this interval has been indefinitely extended, and so far we've saved at least 60 man-hours. Finally, Cellulubes never get 'dirty,' nor do they burn away by friction or compression."

Cellulubes . . . the *safe* lubricants and hydraulic fluids . . . are available in six controlled viscosities. If you'd like a sample for evaluation, please let us know the application involved.

Celanese Corporation of America, Chemical Division, Dept. 596-B
180 Madison Avenue, New York 16, N. Y. Celanese® Cellulube®

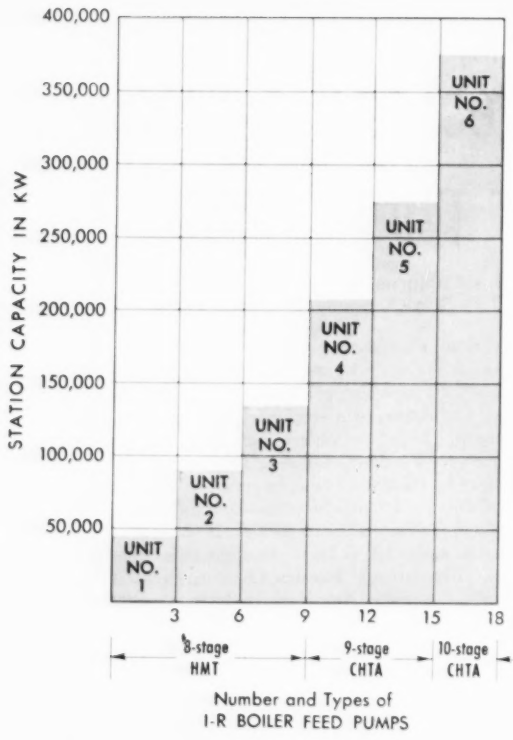
Cellulubes... Celanese CHEMICALS **fire-resistant functional fluids**

Canadian Affiliate: Canadian Chemical Co., Limited, Montreal, Toronto and Vancouver • Export Sales: Amcel Co., Inc., and Pan Amcel Co., Inc., 180 Madison Avenue, New York 16, N.Y.



3 MORE I-R BOILER-FEED PUMPS

serve Unit No. 6 at H. T. Pritchard Generating Station



THIS latest installation at Indianapolis Power & Light Company's H. T. Pritchard Station brings total plant capacity to 376,000 kw—served by a total of *eighteen* Ingersoll-Rand high-pressure boiler-feed pumps.

Unit No. 6 is served by the three 10-stage Class CHTA boiler-feed pumps shown above, each direct driven by a 1250 hp motor and rated 875 gpm with 4451 ft. total head. These pumps feature Ingersoll-Rand's proven double-case construction and "Unit-Type" rotor assembly. And like all I-R boiler-feed pumps at the H. T. Pritchard Station, they are designed to provide top performance and economy under the most severe operating conditions.

This is another case where I-R boiler-feed pumps have *sold themselves* over and over again, on the basis of past performance in the same power plant. For the best solution to your boiler-feed pump problems, just call your nearest I-R representative.

Ingersoll-Rand

10-677 11 Broadway, New York 4, N. Y.

COMPRESSORS • TURBO BLOWERS • CONDENSERS • PUMPS • AIR TOOLS • DIESEL AND GAS ENGINES

TOOL-OM-ETER
The Pulsation Compensated
AIR METER

4 Ranges Covering From
4 to 450 CFM

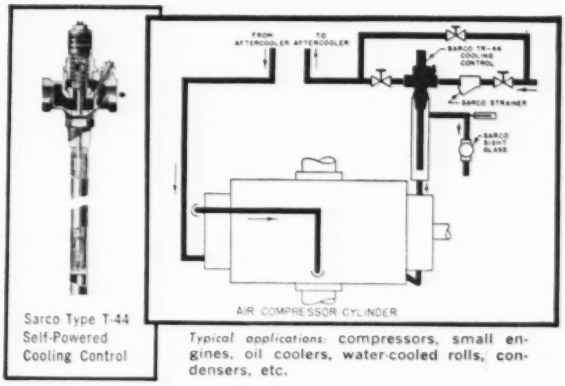
- SIMPLE AND PRACTICAL OPERATION
- RELIABLE AND DURABLE
- PORTABLE FOR FIELD TESTING
- ACCURACY BETTER THAN 1%

New Jersey Air Meters are accepted everywhere as the most practical, reliable and accurate method of air measurement. With the aid of these meters, you can intelligently select the most suitable equipment for your service, maintain this equipment in effective operating condition, make repairs and adjustments when needed, locate leaks and losses, and scrap the "air eaters" when they become obsolete or worn beyond repair.

These meters show directly on a scale, in cubic feet of free air per minute, the flow of air in a pipe or hose. They measure the air consumption of any pneumatic tool, rock drill, air motor, sand blast, air lift, or other application of compressed air. They permit the control of air flow to any operation or process at the rate that gives the most effective production and highest air economy.

FOR THE COMPLETE STORY, WRITE FOR BULLETIN A-8

NEW JERSEY METER CO., INC.
350 Leland Avenue • Plainfield, New Jersey



Sarco Type T-44 Self-Powered Cooling Control

Typical applications: compressors, small engines, oil coolers, water-cooled rolls, condensers, etc.

PROTECT COMPRESSORS
against undercooling and overcooling

Undercooling cuts down compressor capacity . . . often damages cylinders, other parts.

Overcooling increases wear, destroys lubricants, wastes water.

You can avoid these troubles, step up the performance of your compressors, reduce maintenance, save water and lubricants. How? By replacing uncertain manual control of cooling water . . . by *automatic* control with Sarco self-powered temperature regulators.

½" size . . . only about $37

Inexpensive. Simple. Require no outside power source. Packless. Easy to install by any pipefitter.

Write for Bulletin 710B. Sarco Co., Inc., 635 Madison Ave. New York 22, N. Y. 2229-F

SARCO

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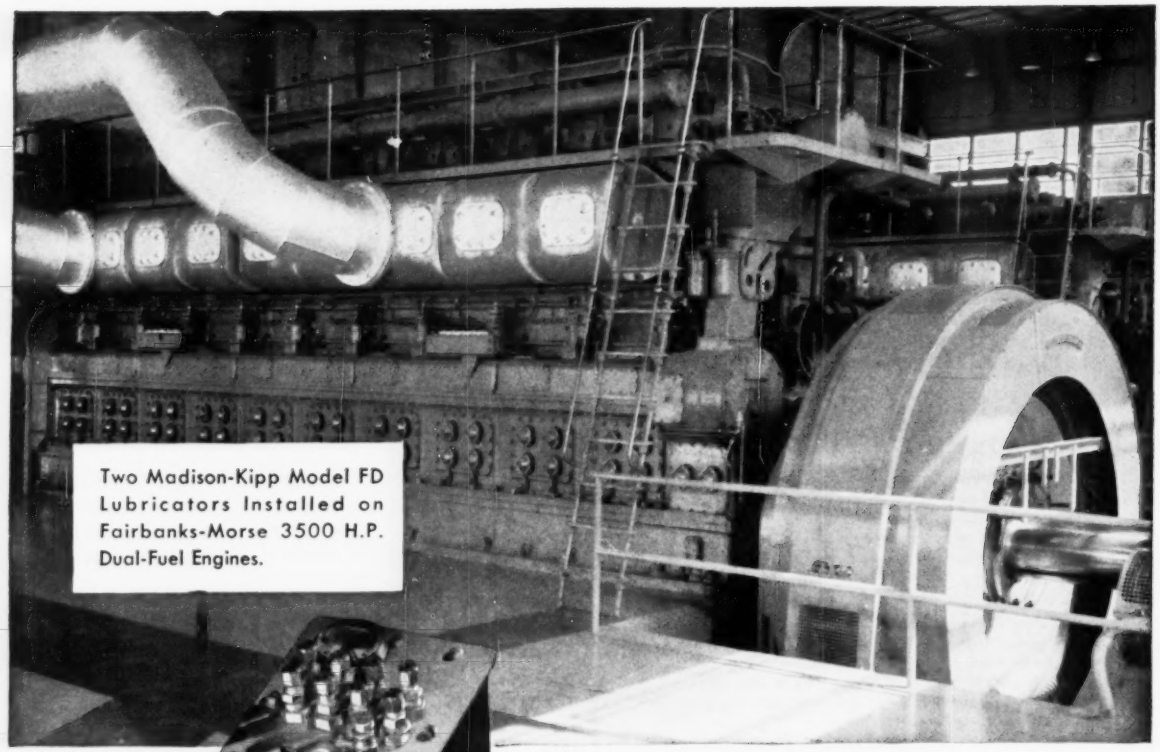
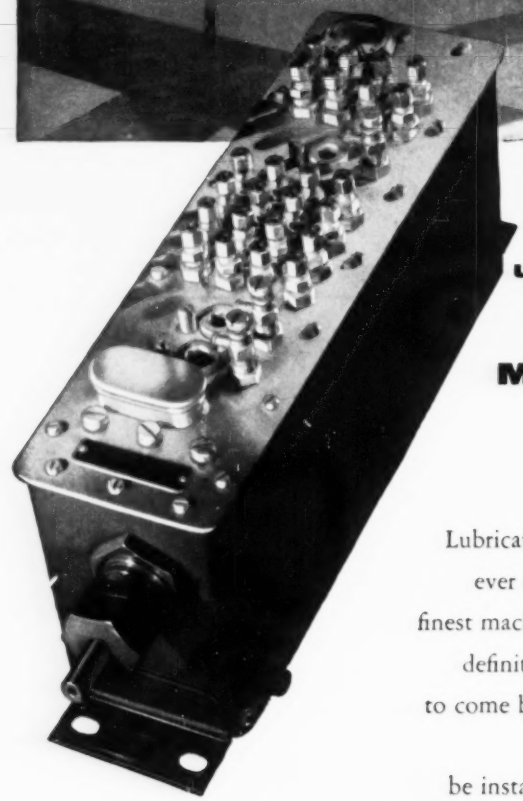


Two Madison-Kipp Model FD Lubricators Installed on Fairbanks-Morse 3500 H.P. Dual-Fuel Engines.



Machines of great performance use the most dependable oiling system ever developed

MADISON-KIPP

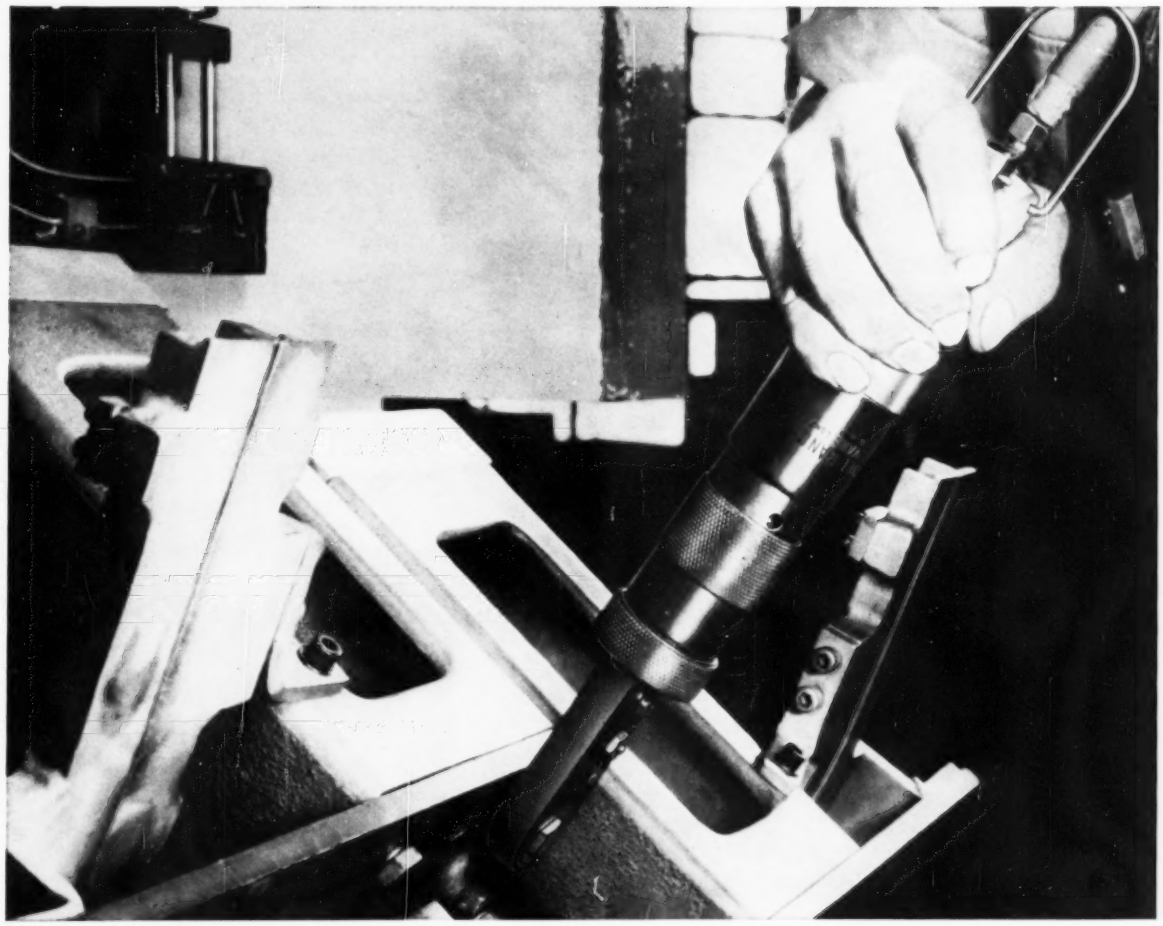
Fresh Oil

...by the measured drop, from a Madison-Kipp Lubricator is the most dependable method of lubrication ever developed. It is applied as original equipment on America's finest machine tools, work engines and compressors. You will definitely increase your production potential for years to come by specifying Madison-Kipp on all new machines you buy, where oil under pressure fed drop by drop can be installed. There are 6 models to meet almost every installation requirement.

kipp

MADISON-KIPP CORPORATION
202 WAUBESA STREET • MADISON 10, WIS., U.S.A.

Skilled in Die Casting Mechanics • Experienced in Lubrication Engineering • Originators of Really High Speed Air Tools



Built to take punishment—001JW Ratchet Wrench shown running car screws on automatic assembly machine. Nickel alloy steel parts minimize maintenance and help keep tool working longer.

How Nickel Alloy Steels help tools like this keep on working for you!

Look carefully at this new pneumatic ratchet wrench made by Ingersoll-Rand. Notice its compactness . . . its short overall length . . . its narrow width . . . its thin ½-inch ratchet head.

These features permit the tool to operate easily, efficiently in tight spots.

Critical parts must be thin yet have excellent toughness and strength to give many years of dependable service. They are made of two nickel alloy steels: type 8640 and 8620.

These steels, with .55% Nickel, give the rotor, gear case, connecting rod and other key parts the extra strength, toughness and wear resistance needed for continuous operation under high stress and shock loads.

There is a variety of nickel alloy steels. Each one a specific for handling special problems of heat, corrosion, wear, strength, or a combination of these factors.

Whether you manufacture or use equipment, Inco's Development and Research Division can help you on material problems. They will be glad to send pertinent information on specific metal problems. Just write for the facts you want.

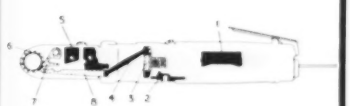
*Registered trademark

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street INCO New York 5, N. Y.

NOTE TO DESIGNERS:

Here's where nickel-containing alloy steels are used in I-R's new pneumatic ratchet wrench:

(1) rotor
(2) gear case
(3) push rod driver
(4) connecting rod
(5) side plate support
(6) socket
(7) socket pawl
(8) push rod



INCO NICKEL

NICKEL ALLOYS PERFORM BETTER LONGER

Name your bearing needs...we'll meet 'em pronto from 30 types, 10,247 sizes

TIME and time again, machinery makers come to the Timken Company for help with some special bearing application problem. One they think hasn't been solved before. And time after time, from our 30 types and 10,247 sizes of Timken® tapered roller bearings, we've come up with the bearing design to do the job and at minimum cost.

It's no accident that we can help out so often. In sixty years of helping machinery builders with bearing problems, we've engineered and produced the world's largest selection of tapered roller bearings. And we've constantly improved our designs. The answers to thousands of bearing application problems are already in our files. Ready and available to help you.

And machine users get the same swift service if they ever need a replacement Timken bearing. Even for old machines, they can almost always count on immediate delivery of Timken bearings for replacement.

Why not call on our engineers for help whenever you have a bearing application problem or requirement? Timken is your No. 1 bearing value. Wherever wheels and shafts turn, Timken bearings eliminate friction, cutting wear and maintenance to a minimum. Specify bearings trade-marked "Timken" for the machines you buy or build. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ont. Cable: "TIMROSCO".

This symbol on a product means its bearings are the best.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS ROLL THE LOAD